A Digital Platform connecting Academia and Small Businesses: An opportunity for Knowledge Management Experiments

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Abstract

Digital transformation is one of the biggest phenomena of this decade. One enabler of this revolution was cloud computing. Today, software engineers can deliver software as a service (SaaS), which is accessible to users through the Internet. Slack, Shopify, and Dropbox are examples of successful SaaS. We are experiencing an emergence of numerous small web applications with easy-to-use features for specific domains such as project management, accounting, resources management, customer relationships, and so forth. Thus, SaaS has been recognised as particularly well suited for the digital journey of small enterprises. However, surveys conducted by governmental agencies reveal a low adoption rate of SaaS by small enterprises in traditional sectors such as construction, services, and dealership. Previous studies have highlighted a lack of top management support, a weak relative advantage perceived, and a lack of knowledge as the key reasons for this low level of adoption. Whilst academic research defines these critical factors, it has not found potential solutions to mitigate them. Thus, this thesis presents two exploratory studies to enhance the adoption of digital practices by small traditional enterprises (STEs).

A first study explored the value of leading collaborative projects between students and STEs about the assessment of SaaS solutions. A secondary objective of this initiative was the design of a platform acting as an open innovation platform. A three-year study allowed the completion of thirty-nine projects and the testing of two different platform designs. The feedback from students demonstrated the value of a well-structured platform composed of different management models for each project phase. Furthermore, 67 per cent of the STEs involved on the platform acknowledged the value of such collaborative projects. However, the collaborations did not improve top management support, and projects tended to stagnate because of various organisational factors.

A second study, using a mixed-methods research design, was performed to explore the relations amongst the organisational factors acting as enablers and barriers to the digitalisation of STEs. The objective was to improve understanding of STEs' situation and devise a proposition to enhance top management support. An academic contribution of this study was the design and application of a conceptual framework combining organisational factors from the literature on dynamic capabilities, organisational inertia, and intellectual capital. The combination of the qualitative observations and quantitative results highlighted the importance of the sensing and leadership capabilities for STE

directors. They also revealed the mediator effect of the relational capability on the development of these latter.

Therefore, this thesis makes important contributions to the literature on open innovation by defining a new field for leading knowledge management experiments. It also contributes to develop a comprehensive overview of the organisational factors affecting STEs' adoption. A further major contribution is the potential value of the digital platform to innovate the services of practitioners, such as governmental agencies and consultants, that support STEs on their digital journey. In conclusion, this research is valuable in opening the discussion about potential innovations that might reshape the relationship between academia and business.

Keywords: Digital transformation, open innovation platform, SMEs, knowledge management systems, industry-university collaboration, community of practices

Résumé

La transformation numérique est l'un des phénomènes les plus importants de cette décennie. L'un des principaux moteurs de cette révolution a été l'informatique dans les nuages (cloud computing en anglais. Aujourd'hui, les ingénieurs en logiciel peuvent fournir des logiciels sous forme de service (appelé solutions SaaS), qui sont accessibles aux utilisateurs par Internet. Slack, Google Apps et Dropbox sont des exemples de SaaS qui sont devenus populaires en un temps record. Ainsi, nous assistons à l'apparition de nombreuses petites applications web (autre nom pour SaaS) avec des fonctionnalités faciles à utiliser pour des domaines spécifiques tels que la gestion de projets, la comptabilité, la gestion des ressources, les relations clients, etc. En outre, une partie importante de ces applications appliquent le modèle économique appelé "freemium", qui offre la possibilité de les tester gratuitement. Ainsi, le SaaS a été reconnu comme l'un des principaux facilitateurs dans la numérisation de petites entreprises. Cependant, les enquêtes menées par les agences gouvernementales révèlent un faible taux d'adoption du SaaS par les petites entreprises dans les secteurs traditionnels tels que la construction et les services. Des études ont défini trois principales barrières, un manque de soutien de la part de la direction, un faible avantage relatif perçu et un manque de connaissances. Bien que la recherche universitaire définisse ces facteurs critiques, elle n'a pas trouvé de solutions potentielles pour les atténuer. Ainsi, cette thèse présente deux études exploratoires cherchant à comprendre comment favoriser l'adoption de solutions digitales par les petites entreprises traditionnelles (STEs).

Une première étude a exploré l'intérêt de mener des projets de collaboration entre des étudiants de master en ingénieurie et des STEs afin d'améliorer l'adoption des nouvelles solutions numériques. Un objectif secondaire de cette initiative était la conception d'une plateforme digitale faisant office de plateforme d'innovation ouverte et d'un système de gestion des connaissances pour améliorer les collaborations. Une recherche-action de trois ans a permis la réalisation de trente-neuf projets et la mise à l'essai de deux plates-formes de conception différente. Les retours obtenus des étudiants a démontré la valeur d'une plateforme bien structurée composée de différents modèles de gestion pour chaque phase du projet. Les étudiants ont également fait preuve d'une plus grande autonomie dans la conduite de leur projet grâce à l'utilisation de la plate-forme. En outre, 67 % des STEs participant à la plateforme ont reconnu l'intérêt de tels projets de collaboration. Cependant, les collaborations n'ont pas amélioré le soutien de la

direction et les projets ont eu tendance à stagner en raison de divers facteurs organisationnels.

Une deuxième étude, utilisant une méthode mixte de recherche, a été réalisée pour explorer les relations entre les facteurs organisationnels agissant en tant que facilitateurs ou barrières à la numérisation des STEs. L'objectif était d'améliorer la compréhension de la situation des STEs et d'élaborer une proposition visant à renforcer le soutien de la direction. L'une des contributions académiques de cette étude a été la conception et l'application d'un cadre conceptuel combinant les facteurs organisationnels de la littérature sur les capacités dynamiques, l'inertie organisationnelle et le capital intellectuel. La conception de ce cadre était nécessaire en raison de la prédominance d'études fondées et axées sur l'adoption de nouvelle technologie, ce qui a entraîné une simplification ou une négligence de plusieurs facteurs organisationnels. La combinaison des observations qualitatives et des résultats quantitatifs a mis en évidence l'importance des capacités de détection et de "leadership" pour les directeurs des STEs. Ils ont également révélé l'effet médiateur de la capacité relationnelle sur le développement de ces dernières.

Par conséquent, cette thèse apporte une importante contribution à la littérature sur l'innovation ouverte en définissant un nouveau champ d'expérimentation pour la gestion des connaissances entre étudiants et STEs. Elle contribue également à la réflexion sur les petites et moyennes entreprises (PMEs) en proposant un cadre conceptuel qui développe une analyse globale des facteurs organisationnels affectant la numérisation des STEs. Une seconde contribution est l'analyse du potentielle de la plateforme à innover les services de soutien aux STEs proposés par des acteurs tels que les agences gouvernementales et les consultants. En conclusion, cette recherche est utile pour ouvrir la discussion sur des innovations potentielles qui pourraient remodeler la relation entre le monde universitaire et le monde des affaires.

Mots-clés : Transformation numérique, plateforme d'innovation ouverte, PMEs, systèmes de gestion des connaissances, collaboration industrie-université, communauté de pratiques

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Abbreviations and Acronyms

CRM: Customer relationship management solution

ERP: Enterprise resource planning solution

KMS: Knowledge management system

SaaS: Software as a Service

SME: Small and medium-sized enterprise

STE: Small traditional enterprise

Chapter 1.

The Digital Transformation phenomenon

In recent years, the "digital transformation" phenomenon, also called "digitalisation", has become a trendy subject because of its major impact on our society. It is interesting to look at our personal environment to observe concrete examples of digital transformation in our daily life. For instance, my six-year-old son, who is starting to read, can recite the names and characteristics of dozens of dinosaurs because he received a digital pen that tells him stories or descriptions about pictures in a book. The digital pen makes exploring a book fun and offers him the time he needs to learn, with the possibility of repeating information as often as he wants, and he is free to select which information to learn. This pen is a nice example of a digital transformation that has empowered my son in his learning process.

From a bigger perspective, an example of a digital transformation that greatly impacted society is e-commerce (Drucker 2002). The trade or sale of goods is a task performed since the dawn of time that has been reshaped in just 20 years by new technologies. The success of platforms like eBay and Amazon in the late 1990s opened the door to the creation of e-commerce platforms for exchanges of everything. The Toptal platform offers simple ways of hiring freelance developers, the Patreon platform lets anyone support creative people with a monthly subscription, and the Kickstarter platform uses the crowdfunding approach to allow start-ups to raise funds from a community of early adopters for launching their new products.

Another type of digital transformation that greatly impacted human behaviour was the creation of Facebook in 2004 (Chandra 2019). The platform has shown great benefits to enhance the social capital of users (Pempek, Yermolayeva, and Calvert 2009), but it also had negative side effect with the apparition of anti-social behaviours when users were frustrated about a low social recognition (Carpenter 2012). The fact that today's parents are still using Facebook for the time they were young highlights change through an inclination to adopt digital solutions in the long term among young adults. The adoption of these new digital ways in people's daily routines was disruptive as it took less than a generation to spread around the world.

From a historical perspective, the digital transformation phenomenon of enterprises started in the late 1950s with the proliferation of computers producing

digital record keeping (Wikipedia 2019). It has been defined as the digital revolution and considered the third industrial revolution. Since this age, the phenomenon has evolved from "the computerizations of tasks to optimize routines" to "the use of new digital technologies (social media, mobile, analytics or embedded devices) to enable major business improvements" (Michael Fitzgerald, Nina Kruschwitz 2013). For instance, the term "Industry 4.0" was presented for the first time in 2011 at the Hannover Faire, which is one of the world's largest trade fairs. It introduced the idea of a fourth industrial revolution through the concept of "smart" factories using a combination of Internet technologies, sensors, robots, artificial intelligence to create a cyber-physical production network among all the stakeholders of a supply chain (Lasi et al. 2014).

Thus, even though this phenomenon started for 50 years, it gained in popularity for the last five years. Figure 1 illustrates the evolution of Google search for the terms "Digital transformation" and "Industry 4.0" in the last five years. The vertical axis shows the percentages of research entered for these terms, compared to the maximum value recorded for this period. This maximum value (represented by 100%) was obtained for the term "digital transformation" at the start of 2019.

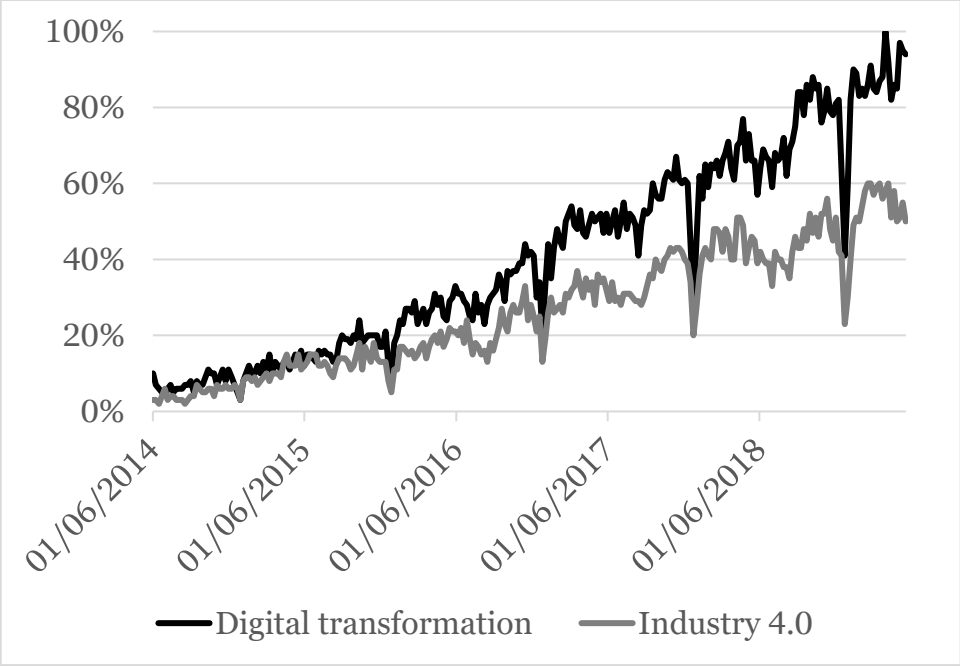


Figure 1: Evolution of Google search for the terms "Digital Transformation" and "Industry 4.0" from 2014 to 2019 (Google Trends 2019).

The interest in these two terms is quite recent and should continue growing. For instance, *The Wall Street Journal* wrote an article about a study that described digital transformation as the biggest risk factor in 2019 for businesses (Mengqi Sun 2018). It increases threats for any organization through business model viability, customer preference shift, and disruptive innovation. Large companies that have long histories, strong operational routines, and legacy technology infrastructure are concerned about their ability to compete with younger companies that use efficient and innovative digital capabilities. For instance, a study by Constellation Research, a Silicon Valley tech research and advisory firm, shows an accelerating rate of change among firms in the famous list of Fortune 500 (Wang Ray 2014). In 1958, corporations listed had an average stay of 61 years. This lifetime dropped to 18 years in 2011. Furthermore, the researchers found that 52% of the companies that had dropped off the list between 2000 and 2014 had done so because of digital disruption.

Having grasped the importance of digital transformation for the business environment, a short discussion highlights its characteristics from a three-level business perspective (corporate, business, functional) to develop our vision of this phenomenon.

From a corporate level, the digital transformation playbook of Rogers (2016) provides a comprehensive overview of the changes brought by the digital transformation for the marketplace. He defines several new strategic assumptions that enterprises should adopt. The changes within the strategical assumptions are represented under five categories in Table 1: customers, competition, data, innovation, and value.

Table 1: How the digital age changed the strategic assumptions of businesses (Rogers, 2016, p.7)

	From	To
Customer	- Customers as mass-market - The firm is the key influencer - Marketing to persuade to purchase	- Customers as a dynamic network - Customers are key influencers - Marketing to inspire loyalty and advocacy
Competition	- Competition within defined industries - Key assets are held inside the firm	- Competition across fluid industries - Key assets reside in outside networks
Data	- Use of structured data alone - Data are a tool for optimizing processes	- Unstructured data are increasingly usable and valuable - Data are a key intangible asset for value creation
Innovation	- Decisions based on intuition and seniority - Testing ideas is expensive, slow, and difficult	- Decisions based on testing and validating - Testing ideas is cheap, fast, and easy
Value	- Value proposition defined by industry - Optimize your business model as long as possible	- Value proposition defined by changing customer needs - Evolve before it becomes essential, to stay ahead of the curve

An interesting remark about these new strategic assumptions is their effect on the increase of the complexity in the business environment. The second industrial revolution was the age of mass production where large enterprises were the key influencers (Niiler 2019). With e-commerce platforms, customers can compare, review, and order products from any enterprise from their homes. Thus, customers are more susceptible to change their purchasing habits, which forces enterprises to carefully analyse customers behaviours (Su 2017). Digitalisation is also causing a radical reordering of traditional industry boundaries. For instance, the banking sector is suffering from the competition of big supermarkets that proposes their own credit cards with loyalty points to their customers (Atluri, Dietz, and Henke 2017). To deal with the threats of losing customers because of a new unseen competitors, enterprises

have started to look at the value of unstructured data to improve their perception about marketplace changes (Gandomi and Haider 2015). Another way of maintaining a competitive advantage for enterprises is to use new technologies to speed up their innovation process. Those technologies are also critical in monitoring changing customer needs, which produce essential insights about potential business model innovation.

From a business level, consultancy firms such as Capgemini, Deloitte, and SAP propose similar frameworks to lead digital transformations. Deloitte promotes the necessity for enterprises to align their culture, people, structure, and tasks through a strategy of continuous feedback for improving the learning and adapting capacity (Kane et al. 2016). To align the enterprises, Capgemini designed a digital compass to develop adequate leadership capabilities through the realization of four phases, which are 1) framing the digital challenge, 2) focus investments, 3) mobilize the organization, 4) sustain the transformation (Westerman, Didier Bonnet, and McAfee 2014). Thus, the digital compass support enterprises in the application of an iterative learning process for leading digital transformation. Additionally, Uhl and Gollenia (2015) define three enablers and three objectives of digital transformation. The enablers are innovation capability, transformation capability, and IT excellence. The innovation capability is crucial for framing the digital challenge, while the transformation capability allows enterprises to focus investments and mobilize collaborators, and IT excellence is necessary to sustain the transformation. Thus, digital transformation frameworks are consistent about the need for enterprises to enhance their leadership, innovation, and transformation capabilities to succeed in digital transformation through the application of rapid iterative learning loops. The three objectives for digital transformation are customer-centricity, effective knowledge workers, and operational excellence (Uhl and Gollenia 2015). A fourth one proposed by Westermann et al. (2014) is business model innovation.

From a functional perspective, it is interesting to look at the technologies that potentially enable enterprises to reach the four objectives of digital transformation. Using a report by the consultancy firm SAP (2015), five key domains of a firm have been defined as categories that encompass various technologies related to digital transformation. They are workforce engagement, supplier collaboration, customer relationships, operational processes, and asset exploitation (see Table 2).

Table 2: A non-exhaustive list of technologies or digital solutions with potential for digitalisation, classified under five domains

Five domains of a firm with strong potential for digitalisation	Workforce engagement	KMS, mobility, virtual reality
	Supplier collaboration	Dynamic network, digital platform, blockchain
	Customer relationships	E-commerce, digital marketing, CRM solutions
	Operational processes	ERP solutions, automation, 3D printing
	Assets exploitation	Internet of Things, big data, machine learning

1) Workforce engagement encompasses not only the adoption of new digital practices but also dimensions such as organizational culture and leadership. However, the fact that new information technologies can be used as a supportive means for empowering employees points out workforce engagement as one of the main domain for digital transformation (Psoinos, Kern, and Smithson 2000). The term "empowerment" has become popular in business literature related to digital transformation. Social media and collaborative solutions are used to create efficient knowledge management systems (KMSs) to motivate and support employees in their jobs (Schneckenberg 2009). Enterprise mobility lets employees work from anywhere, which leads to an increase in productivity and job satisfaction (Newman 2016). It enables employees to actively participate in core processes even if they are not sitting at their desks. Finally, combining knowledge systems and mobility through virtual augmented reality is the new trend to empower employees (Fade 2019). For instance, Walmart purchased 17 000 Oculus Go headsets to develop a nationwide employee training program. It will allow employees to learn and will train their skills to improve performance regarding internal process management. The program will also reduce the cost of conducting experiments to test the value of new processes.
2) Supplier collaboration concerns all the technologies that would help to shift a supply chain from a linear model to a more dynamic one. Dynamic network emphasizes the new reactivity that a supply chain might acquire by interconnecting activities such as connected customers, synchronized planning, intelligent supply, and dynamic fulfilment (Mussomeli, Gish, and Laaper 2016).

Developing appropriate digital platforms is essential in creating a dynamic network. Each stakeholder of a supply chain must have a reliable platform that gathers all data from interconnected activities, and it should be able to communicate with other stakeholders' platforms. Blockchain technology seems to offer the potential for improving the speed and reliability of the exchanges within a network (Marr 2018). To do so it uses its ability to create smart contracts.

3) Customer relationships, as previously discussed, have changed profoundly with e-commerce. However, e-commerce remains specific to a certain type of industry. The same is not true for digital marketing and customer relationship management (CRM) solutions. Digital marketing through social networks is becoming an essential capability for every firm (Tiago and Veríssimo 2014). It is vital for the firm's reputation and it offers efficient ways to acquire new clients. Companies' interest in CRM solutions has been increasing over time. These solutions aim to improve a firm's relationships with customers by creating a database of profiles and monitoring its activities to reduce errors or oversights.
4) Benefits of enterprise resource planning (ERP) software for improving operational processes have been discussed for many years (Shang and Seddon 2000). Although this type of solution has a history going back to the 1960s, it remains a core digital capability that companies aim to acquire during their digital journey. A more recent topic about process innovation is automation technologies. The development of complex robots is likely to become the next disruption in human history with predictions from experts that 40% of current jobs could disappear in the next 15 years (Reisinger 2019). Furthermore, combining automation to 3D printing could allow the manufacturing industry to move from the "one size fits all" strategy to mass customization (Rogers, Baricz, and Pawar 2016).
5) An emergent domain is the improvement of asset exploitation through new technologies such as the Internet of Things, machine learning, and big data. Although the past decade has seen rapid growth in the research on these new technologies, their adoption at a large scale is still in the early phase (Gandomi and Haider 2015; Hashem et al. 2015; Jordan and Mitchell 2015). For instance, research on machine learning and big data have led to many studies in the medical sector to improve the detection of cancers (Kourou et al. 2015). Even if the results obtained in recent years were promising, the adoption by doctors remains slow. Among the three technologies, the Internet of Things is becoming more concrete for enterprises, given the cost reduction and spread of technologies such as radio-

frequency identification (RFID) and different types of sensors for proximity, motion, and so on. This offers much value for the supply chain sector (Li, Xu, and Zhao 2015).

Therefore, the digital transformation phenomenon is a complex topic that 1) involves major new assumptions from a corporate level, 2) requires important efforts from a business level to change and align leadership, innovation, and transformation capabilities, and 3) encompasses numerous different technologies that can be integrated in many different ways from a functional level. This introduction about the digital transformation revealed the immensity of the phenomenon. We might wrongly assume that only large enterprises are concerned by this phenomenon due to its complexity, which requires resources that small enterprises do not usually have (Hadjimanolis 2000). However, another phenomenon, called the democratisation of information and communications technologies (ICTs), made possible for small enterprises to start their digital journey through the use of cloud computing technology (Sultan 2013). The next section introduces the small enterprise' situation facing the digital transformation phenomenon. It highlights the anomaly between the real opportunity for them to lead digital transformation and their current low level of digitisation. This anomaly establishes the foundations for this thesis.

1.1. Small enterprise context

The democratisation of ICTs is not simply due to the creation of cloud computing, but it is also the result of the exponential cost reductions and performance improvements of transistors since 1971 (Bresniker 2018). In human history, this is the unique technology that has been able to follow this exponential evolution. For instance, a high-end desktop computer with a processor of 1 GHz cost a few thousand Swiss francs 20 years ago, whereas today a cheap smartphone with a quad-core of 1 GHz costs 50 Swiss francs. Thus, this growth was the first step to the ICT democratisation by offering anyone the opportunity to acquire adequate IT infrastructure to start a digital journey.

The second enabler of this democratisation can be described as the second main evolution related to the rise of the Internet since the mid-1990s. Cloud computing, together with the growth of the Internet speed and network, is reshaping the foundations of the digital world. The National Institute of Standards and Technology defined cloud computing as follows:

> a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell and Grance 2011).

In other words, it allows a small enterprise to use computing resources through the Internet instead of having to buy, set-up, and manage its own system. With the appearance of cloud computing, new solutions – called software as a service (SaaS) or web applications – have flourished on the Internet. SaaS is software developed on cloud computing infrastructure, which makes it usable through the Internet. SaaS triggered important changes in the software development sector, with the possibility to reach a worldwide market for a minimal cost. The advantages of this solution include rapid elasticity, on-demand self-service, reduced costs for infrastructure, fewer skills required for maintenance and implementation, and reliability of service. These advantages are especially suited to SMEs' constraints (Dillon, Wu, and Chang 2010; Jadeja and Modi 2012; Marston et al. 2011).

A great example of SaaS is the video game industry proposing complete gaming experiences through cloud solutions, which would make game consoles redundant. The video game would be streamed directly to the TV with a real-time exchange between the cloud and the gamepad. This change is also observable in the business world, with digital solutions becoming cheaper and usable from everywhere. On the one hand, this democratisation is the root of the risks perceived by larger firms that compete with younger ones born during the digital revolution. On the other hand, this democratisation provides ample opportunity for small and medium enterprises (SMEs) to start their digital journey.

Furthermore, the application by software companies of the new business model called "freemium" through cloud computing solutions allows SMEs to test many different solutions before making a choice. The "freemium" concept is "a way of charging for a product or service in which the basic product or service is free, but the customer pays for extra features" (Cambridge Dictionary 2019). For instance, the SaaS solution called Odoo proposes a platform with applications for ERP, CRM, accounting, digital marketing, and so on. A user can create an account and start to use one of its sub-application for free in a few minutes, but it would have to pay between 8 to 20 euros per additional applications.

It thus seems reasonable to expect SMEs to take the opportunity to start their digital journeys with such flexible digital solutions. Unfortunately, recent statistics reveal that most SMEs have not yet adopted cloud solutions. A survey by the European Commission assessed the level of digitisation and other organizational factors among small, medium, and large firms in Europe (DESI 2018). The results revealed that only 13% of small firms with fewer than 50 employees had an ICT specialist, whereas 74% of firms with more than 250 employees had at least one. The survey also shows an important difference in the level of digitalisation regarding the firm's sector. Only 7% of firms in the construction sector were highly digitalised, compared to 20% in the manufacturing sector, 30% in the trade and service sectors, and 64% in the IT sector.

The study also compared the type of digital technologies adopted by SMEs and large firms (see Figure 2). It revealed that cloud computing lagged well behind ERP, CRM, and social media adoption. A clarification about the distinction between social media and cloud computing is required to truly understand these results. If we are looking at social media applications, they can be considered as SaaS solutions using cloud computing. Logically, firms that are using social media, are also using cloud computing. However, the results suggest that enterprises are doing the distinction between cloud and social media. The same argumentation cloud be done about the distinction between cloud computing and ERP. The Odoo solution previously discussed is a perfect example of an ERP/CRM solution based on cloud computing. It is highly probable that a part of the respondents is using ERP SaaS or CRM SaaS without considering it as cloud computing usage. Thus, results about cloud adoption should be treated with cautions as it is not necessarily representing the reality but more the perception of the respondents, which are not fully aware of the true meaning of cloud computing (McKendrick 2012). We can assume that the general perception that produced the low percentage revealed in the survey restricts cloud usage to the use of a virtual space to store, access, and share internal data of the enterprises through the Internet.

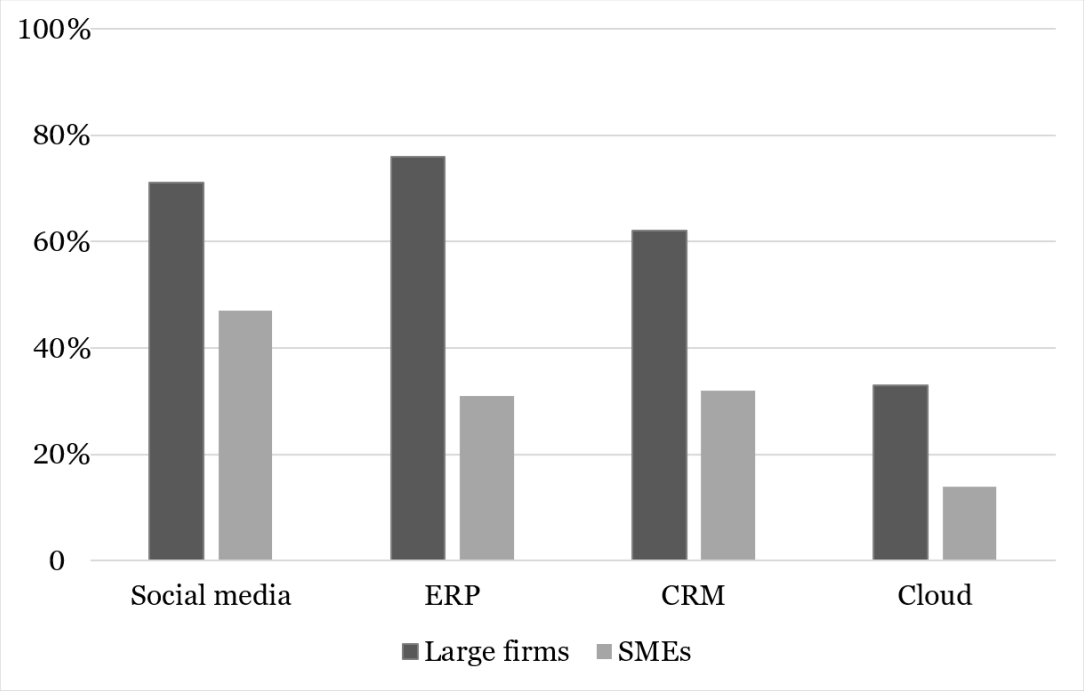


Figure 2: Adoption of social media, ERP solutions, CRM solutions, and cloud solutions among European large firms and SMEs (adapted from DESI (2018))

Even though SMEs do not necessarily grasp the whole value of cloud computing, this low adoption rates highlights an inconsistency between SaaS that has been previously defined as an opportunity for SMEs versus their actual adoption behaviour. For instance, inconsistency in information sharing is often stated as the main problem for small firms working in the construction sector, which might be greatly improved through the use of basic applications of cloud computing (Oliveira, Thomas, and Espadanal 2014).

The anomaly about the low level of adoption from a specific type of SMEs, which is the traditional small enterprises (STEs) defines the scope of this thesis. Thus, highlighting the difference between STEs and SMEs is important for our understanding of the research. Previous studies have shown the importance of splitting SMEs into sub-categories because of their different entrepreneurial attitudes toward innovation and firm growth (Lejpras 2009; Maçãs Nunes et al. 2010).

Figure 3 represents four sub-categories of SMEs defined by their sizes (small and medium) and their working sectors (traditional or technology-related).

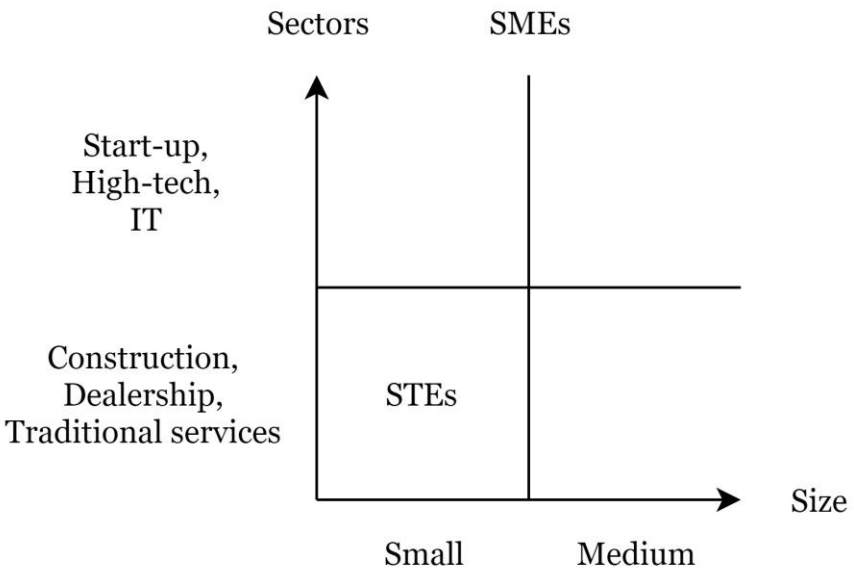


Figure 3: Representation of STEs as a sub-category of SMEs

The digital transformation is a broad topic that produced literature with many different perspectives about ICT adoption by SMEs. The term SMEs is too often used without given enough precision about the type of firms analysed into the studies. For instance, reviews of the literature on ERP adoption in SMEs have shown that researchers are using the term SMEs for medium manufacturing enterprises (Aloini, Dulmin, and Mininno 2007; Haddara and Zach 2011). A similar observation might be done about e-commerce adoption in SMEs that is focusing on sectors such as manufacturing, dealership and trading services (Ghobakhloo, Arias-Aranda, and Benitez-Amado 2011; Scupola 2009). Finally, SMEs such as High-tech start-ups, IT firms, consultancy firms are outside of the scoop of this research because of their strong affinity to new technology, which is not comparable to STEs' situation. Thus, the terms STEs and SMEs are used to clarify the level of analysis for the different part of this thesis.

1.2. Thesis structure and contribution

Through this introduction, we understood that digital transformation is a phenomenon with major repercussion on the global marketplace. Its complexity requires enterprises to develop new leadership and digital capabilities to remain competitive. Even though SaaS has been described as a good opportunity for STEs to develop digital capabilities, STEs are still reluctant to start their digital journey. This anomaly lays the foundations for a research proposal.

Chapter 2 establishes the research proposal by reviewing the different streams of literature related to SMEs' digital transformation. The chapter begins with a general discussion on the current state of research about the adoption of new technologies by SMEs. Then, the literature review is narrowed down and a deeper analysis of cloud computing and SaaS adoption by SMEs is proposed. Two main categories of factors have been identified as essential. These are technological (relative advantage, compatibility, complexity) and organizational (top management support, organizational readiness, employees' skills). However, the predominance of quantitative studies related to the analysis of these key factors suggests two research gaps.

The first research gap is related to this stagnation of confirmatory studies about the key factors of adoption. Researchers should use the findings of these factors to lead further research on initiatives to enhance STEs' digitalisation. This need to lead experimental research into this field establishes the main research question of this thesis:

How STEs' digitalisation phenomenon could be efficiently enhanced?

The terms "efficiently enhanced" stands for the necessity to figure out a strategy that could be easily applied by a majority of STEs. This research question is the common thread of the research presented in Chapter 3.

The second research gap came from the repetitive application of the same technology-oriented models to asses factors affecting cloud computing adoption by SMEs. As mentioned earlier, organizational factors are defined as critical for cloud computing adoption. However, only a few studies have attempted to deepen these findings by applying organizational behaviour theories – such as dynamic capabilities, intellectual capital, and organizational culture – to understand how

organizational factors affect SMEs' adoption. This thesis explores the effect of such factors on STEs' adoption in Switzerland, a previously unexplored field. Thus, a second research question of this thesis is:

What are the organizational factors affecting STEs' digitalisation?

This second question leads to a second study presented in Chapter 4. Swiss STEs are presented as the research context of this thesis. To strengthen the relevance of the research questions in this context, a small exploratory survey concludes Chapter 2 by providing insight into the real-life situation of cloud computing adoption by Swiss STEs.

Chapter 3 aims to answer the first research question. A few studies have highlighted the value of open innovation strategies and collaborations with external actors such as clients, suppliers, academia, and governmental agencies to improve the innovation performance of SMEs. Combining the concept of an open innovation platform to previous literature findings discussing the students' value to support STEs, a first study applying action research was designed to explore the value of a digital platform connecting students and STEs to foster digital transformation.

A short review of the literature on open innovation, knowledge management, and models of organizational change defines the overall platform design and a secondary research question is defined to assess:

What is the value for academia and STEs to collaborate on projects about digital transformation through a digital platform?

The action research design follows a methodology composed of iterative loops for developing and testing the platform. A detailed description of the six loops conducted during a three-year experiment highlights the evolution of learning. A total of 39 projects were run on two platform designs during these six loops. The performance obtained on each platform was assessed through analysing the five activities of a knowledge management system. These are creation, validation, presentation, distribution, and application of new knowledge.

The study produced innovative contributions from theoretical and pragmatic perspectives for academia and business. For academia, the realization of 39 collaborative projects between students in engineering and STEs produced a

reliable dataset regarding the students' value to support STEs in their digital journeys. One contribution of this action research was the assessment of the analytical and soft skills of students to lead small collaborative projects. Furthermore, two designs of a digital platform were tested to improve collaboration. The comparison of the two designs showed interesting results regarding the best manner to empower students and improve knowledge creation and transfer within STEs.

Chapter 4 applies mixed-method research to answer the third research question. The chapter is concerned with the organizational factors impacting the adoption of new digital practices within STEs. A conceptual framework to explore the organizational factors affecting STEs' adoption is established through a review of literature related to firms' innovation performance. Examples of relevant topics are intellectual capital, dynamic capabilities, organizational culture, and organizational inertia. The framework is tested through a multiple case study and a survey. The case studies are a selection of 11 STEs. Using cross-case synthesis, initial observations are made about the importance of intangibles such as leadership and relational capabilities for STEs' digital transformation. Then, the results of a survey on organizational behaviours of 211 STEs are reported. An exploratory factor analysis identified the relevant items and factors for the STE context, which provides further evidence of the validity of the qualitative observations.

A contribution of this chapter is the combination of different organizational behavioural theories under a same conceptual framework. Another contribution of this mixed-method research is the demonstration of the value added by combining qualitative and quantitative data to develop a better understanding of the results. For instance, qualitative observations are used to define the cause explaining the negative correlation between the leadership capability and the behavioural inertia of employees.

Chapter 5 presents the conclusions and perspectives of this thesis. A review of the two studies presented in this thesis under the concept of engaged scholarship empathizes the pragmatic value of the conclusions. The contribution of the action research to the open innovation literature highlights the value to explore new fields such as academia- STEs collaborations that might benefit from open innovation strategies. Combining the findings from the first and second study, important contributions to the SMEs' literature are provided about key enablers for STEs' digitalisation.

Then, the opportunity for academia to lead knowledge-management experiments in the unexplored field of STEs' digitalisation create new perspectives for research on soft skills, community of practices, gamification, and machine learning. The weaknesses observed during the collaborative projects conducted on the platform are discussed and suggestions are made for improvements. The leadership capabilities were analysed in the mixed-method study, and their interdependence with relational capabilities is highlighted. Using the observations from both studies, a methodology to increase digital and leadership capabilities of STEs is proposed. Finally, a discussion of the key roles played by various stakeholders – such as academia, students, governmental agencies, consulting firms and STE directors – concludes this thesis. A novel view is discussed regarding an opportunity not only for STEs but also for academia to further their digital journeys.

Overall, this thesis asses the opportunity created by the democratisation of ICTs for research in the field of STEs. It also sheds light on the potential value to design digital communities for practitioners and for academia to innovate new ways of managing or teaching digital transformation.

Chapter 2.

A Research proposal

A literature review about ICT adoption within SMEs defines the research gaps related to STEs' digitalisation. A count of the number of articles related to the adoption of different technologies by SMEs – such as e-commerce, ERP, social media, cloud, KMS, CRM, etc… – points out which domains received researchers' attention. More specifically, the discussion focuses on findings from research on three domains of digitalisation – such as operational processes, customer relationships management, and workforce engagement – to look at their value from a STEs perspective. This short review highlights the potential of cloud computing to foster STEs' digitalisation into these three domains. However, as discussed in Chapter I, STEs' adoption of cloud computing remains slow. A review of the cloud computing literature reveals a predominance of quantitative studies using technology-oriented models. A comparison of the findings from recent quantitative studies points out a list of technological and organizational factors affecting cloud computing adoption. Two research gaps are defined based on these findings.

1) Cloud computing has a great potential for STEs' digitalisation and academic literature has defined the enablers that might foster its adoption. The logical next step for research would be to explore solutions to develop those enablers within STEs. However, a gap is found about the lack of case studies assessing initiatives, programs, or experiments on this topic. Thus, the idea of designing a digital platform to allow STEs to collaborate with students on the research of digital transformation is presented as an experiment to develop the key factors necessary to STEs' digitalisation. The value of leading research on the design of this digital platform is supported by previous studies that analysed different type of academia-business collaborations. A second research question related to this first research gap is defined to assess the value of the digital platform from an academic perspective.
2) A global observation about the studies exploring key factors affecting cloud computing adoption was the lack of organizational behaviours theories applied to analyses the phenomenon. The fact that organizational factors are key enablers for

cloud computing adoption lead to the establishment of a second research question to deepen the analysis of the importance of those factors.

At the end of the chapter, the Swiss STEs context is presented as an adequate field for exploring STEs' digitalisation phenomenon. Furthermore, data from a survey on cloud computing adoption of 79 Swiss STEs presents preliminary findings supporting the pragmatic value of this thesis.

2.1. Literature review

The digital transformation phenomenon is a vast topic encompassing numerous different technologies and digital solutions. Furthermore, the academic literature is using the acronym SMEs to discuss research about firms from every sector from a size from 1 to 250 employees. It leads to academic articles with similar titles and keywords but completely different fields of research. Thus, to quickly grasp the current situation of the literature related to STEs' digitalisation, our review starts by assessing the different streams of literature according to the adoption of a specific technology, such as ERP, CRM, KMS or cloud computing. To assess the level of maturity, an analysis of the number of articles published on these different topics was performed using the databases of four famous publishers: Elsevier, Emerald, Sage, and Wiley. The publishers were chosen according to their affiliation to high-ranked journals that publish SME studies. The analysis started with a search of articles related to the general concept of ICT adoption by SMEs. In this case, an advanced search was used to look for article titles with the following keywords: *(SMEs OR SME OR "small business" OR "small firm" OR "small and medium") AND ("Information technology" OR "information and communication" OR ICT)*. It is important to note that the keyword "adoption" was not used. This means that some articles might discuss other technological dimensions, such as new benefits or features of the technology within the SME context.

The same search was repeated with other keywords related to the different technologies (see Table 2 in Chapter I) belonging to the digital transformation phenomenon. Table 3 gives a clear representation of the level of interest that the different digital technologies have received by researchers.

Table 3: Number of articles per type of technologies in the SMEs context retrieved from four databases in Jun 2019

Database / Keywords (SMEs OR SME OR "small business" OR "small firm" OR "small and medium") AND …	Elsevier	Emerald	Sage	Wiley	Total
("Information technology" OR "information and communication" OR ICT)	42	45	17	26	130
E-commerce	17	41	8	15	81
(ERP OR "enterprise resource planning")	21	29	2	2	54
Social media	12	13	1	2	28
Cloud	15	9	0	2	26
(KMS OR "knowledge management system")	8	6	2	2	18
(CRM OR "customer relationship management")	4	10	1	1	16
Automation	7	4	0	1	12
Big data	3	2	1	5	11
Mobility	0	4	0	5	9
Digital marketing	0	6	1	0	7
(IoT OR "Internet of things ")	1	2	0	0	3

The numbers disclosed in Table 3 is a rough count of articles found for each technology in the SMEs context. The choice of applying a filter on the presence of keywords into the articles' titles has probably neglected a number of relevant articles. The same could be argued with the restriction of the analysis to only four databases. For instance, a literature analysis presented later on in the chapter has reviewed 49 articles related to KMS in SMEs (Cerchione, Esposito, and Spadaro 2016), which is quite different from the 18 of Table 3. Thus, this comparison does not aim to produce

an exhaustive analysis of the papers related to SMEs' digital transformation, but it is still a valuable approach to develop our perception of the field of research about SMEs' digitalisation.

The general topic of ICT within SMEs is, without surprise, the one that produced the highest number of articles. This result suggests that researchers have well understood the importance of new ICT for SMEs. The same observation is made for other technologies such as ERP or E-commerce that have a long history with proven results in the industry. However, the relatively low number of articles regarding the application of technologies such as social media, cloud computing, KMS, and CRM is surprising considering their popularity in the business world. As highlighted in Chapter 1, these technologies are the new buzzwords of consultancy and IT firms to promote digital transformation (Brown 2016; Hardy 2018; SAP 2015; Uhl and Gollenia 2014). This observation might be considered as an insight about a gap into the SMEs literature.

Furthermore, only a few articles were found on subjects as automation, big data, mobility, digital marketing, and the Internet of things. The low results obtained for automation, big data, and the Internet of things are understandable as these relatively recent technologies more fitted to large firms that have the resources to use them. However, digital marketing and mobility are accessible technologies well fitted to the SMEs' environment. This point might reveal an interesting gap for further research.

Finally, the research of articles on technologies such as machine learning, blockchain, virtual reality, and 3D printing did not produce any result. Indeed, these technologies are emerging technologies that are still difficult to apprehend for businesses.

It is worth mentioning that the number of articles per year on ICT adoption by SMEs has grown over the last 20 years. The classification of publication dates over a period of four years reveals this evolution. The 130 articles highlighted in the first row of Table 3 were classified into five periods (see Figure 4). The fact that the number of articles published per year is increasing illustrates the growing interest of researchers for this topic.

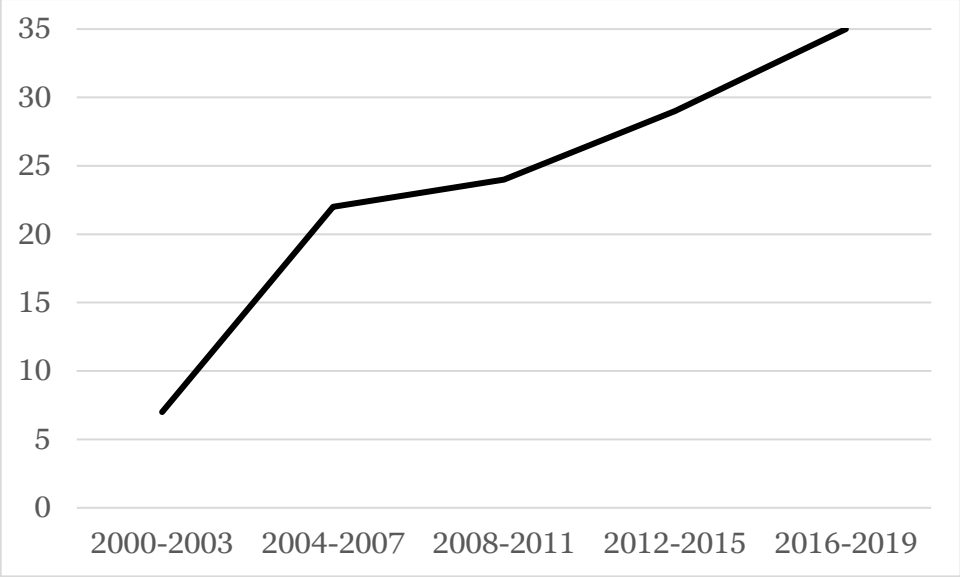


Figure 4: Number of scholarly articles on ICT adoption by SMEs since 2000

Using the results of Table 3, we understood that three over the five domains of digitalisation (see Table 2, Chapter 1) have been discussed in the SMEs literature. In the context of this study, a short discussion highlights the potential value of digitalisation for STEs related to these three domains, which are operational processes, customer relationships management, and workforce engagement for STE.

2.1.1. Operational processes

Research on operational process digitization within SMEs has mainly been explored through the adoption of ERP within the manufacturing sectors (Haddara and Zach 2011). A few quantitative studies have provided comparative analyses between SMEs and large firms regarding factors that affect ERP adoption. Buonanno et al. (2005) showed that company size was a predictor of ERP adoption, whereas business complexity was not. This finding reveals that companies do not necessarily adopt ERP solutions when their business complexity increases unless their size also increases. The authors also highlighted structural and organizational reasons as primary causes for non-adoption of ERP systems, whereas financial constraints were secondary. They concluded by highlighting the tendency of SMEs to cite exogenous reasons like “an opportunity in the moment” rather than business-related factors to justify an implementation. Shiau et al. (2009) provided similar conclusions on the importance of a directors’ characteristics to perceive the benefits as the main enabler. Whereas

large firms struggle with the organizational changes associated with ERP adoption, SMEs deal more with knowledge constraints (Laukkanen, Sarpola, and Hallikainen 2007). Furthermore, these studies also suggest that small and medium firms should be separated into two distinct categories. Medium firms (from 50 to 250 people) display different behaviour from that of smaller firms (1 to 50 people) regarding ERP adoption. Thus, it appears that ERP solutions are not adopted by STEs because of their small size and their lack of benefits perceived.

Recent studies on ERP have examined the potential of SaaS solutions, also called cloud ERP for SMEs. They offer access to the features of an ERP system without the investment and management cost associated with a classical set-up of an on-premise solution (Johansson et al. 2015). The easiness to develop and roll-out cloud computing application has led to the creation of dozens of small low-cost ERP SaaS developed by unknown software companies. This has created new concerns about the vendor's reputation, the customization and integration of the solution, and the availability of the vendor to support the customer (Lewandowski, Salako, and Garcia-Perez 2013; Seethamraju 2015). Furthermore, lack of knowledge and data security concerns are the first barriers that hinder SMEs' motivation to look at ERP SaaS (Gupta et al. 2017; Salum and Zaidi 2016). Then, compatibility, top management support, technology and organizational readiness are key factors in the adoption process (AL-Shboul 2018; Bharathi and Mandal 2015). Overall, the literature describes ERP SaaS as a real opportunity for SMEs. However, if we look at the case studies presented in the literature, they are usually medium firms, which are not considered as STEs (Lewandowski et al. 2013; Seethamraju 2015). Thus, it would be interesting to assess the STEs' perception of ERP SaaS value.

2.1.2. Customer relationships

Digitalisation of customer relationships has been explored through research on solutions such as digital marketing, e-commerce and CRM solutions (El-Gohary 2010). Studies on this subject have defined a list of critical factors similar to those related to ERP adoption; these include directors' characteristics, employee involvement, and firm size (H. Nguyen and S. Waring 2013; Ramdani, Kawalek, and Lorenzo 2009; Scupola 2009). In addition to those common factors, external pressure from clients or partners was perceived as significant for the adoption of CRM solutions. A difference with ERP studies was the participation of STEs into qualitative

studies assessing CRM adoption (Alshawi, Missi, and Irani 2011). Furthermore, cloud computing has profoundly reshaped the business of CRM solutions, with popular SaaS solutions such as Dynamics, Zoho, HubSpot, and Insightly. Those solutions are getting thousands of reviews from small firms, which demonstrates their potential value for STEs (Capterra 2019). Surprisingly, to date, no research has been conducted on the opportunity brought by those new CRM SaaS solutions for STEs.

Furthermore, customer relationships digitalisation is not restricted to the use of CRM solutions. A quantitative study showed the importance for micro and small firms to take advantage of social media application to improve or create customer relationships (Ainin et al. 2015). The emergence of these new ways of engaging customers has created immature markets with strong potential for STEs. The survey revealed that Facebook usage had a strong positive impact on the financial performance of SMEs; it also positively impacted non-financial performance in terms of cost reduction for marketing and customer service, improved customer relations, and improved information accessibility. Although many small firms have started to use social media to interact with customers and to grow their firms' reputations, they still lack competences to use customer information for driving strategic decisions (Harrigan and Miles 2014; Harrigan, Ramsey, and Ibbotson 2012). Through action research with eight small firms from traditional and high-tech sectors, Durkin and McKeown (2013) highlighted the tendency of those firms to adopt new social media because of concern about missing an opportunity, rather than to follow a strategic plan to enhance customer value. Thus, social media plays a key role in the STEs' digital journey, but further research is still necessary to analyse good practice into the usage of social media by STEs.

2.1.3. Workforce engagement

The adoption of new digital practices to enhance workforce engagement within SMEs has not yet received attention from academia. Thus, we extended our literature research to include articles on the empowerment of employees and its effect on a firm's performance. Previous research highlighted the importance of empowerment for large firms (Zhang and Bartol 2010), and subsequently, a few studies have analysed its effect on innovation performance in SMEs. Helmy and Rabiatul (2019) analysed 360 answers of SMEs' employee on the role of empowerment and knowledge sharing in innovation capacity. They found that characteristics such as meaning, competence,

and self-determination were positively related to innovative work behaviour. Furthermore, knowledge sharing mediated the relationship between meaning and self-determination. In other words, knowledge sharing enables employees to develop a strong sense of meaning regarding their work, which increases their self-determination.

Cerchione and Esposito (2016) reviewed 49 articles related to knowledge management in SMEs. Over the 49 articles, 29 are related to the use of KMS to enhance the creation, transfer, and storage of knowledge. Systems such as ERP, CRM, and document-management systems were described as KMS for information storage. Thus, solutions such as ERP and CRM also impact workforce engagement although they are related to the digitalisation of operational processes and customer relationships.

Another survey with data from 109 directors of SMEs showed that IT capability, such as information sharing and work coordination, was positively correlated with innovation (Kmieciak, Michna, and Meczynska 2012). In other words, new information management systems and collaborative solutions have demonstrated benefits to improve the knowledge-creation process within SMEs (Lopez-nicolas and Soto-acosta 2010). These applications focus on improving internal communications with solutions such as messenger application, project management system, wikis, blogs, or intranets. For instance, Slack is a famous SaaS offering enterprises a messenger application to centralize internal communications for facilitating the exchange and research of information. Through a cross-case analysis of six case studies, Zeiller and Schauer (2011) highlighted the potential of these applications to assist people to work more efficiently in their daily routines. They identified two key factors for successful adoption, namely promoters and management support. Overall, Cerchione and Esposito (2016) emphasize the need to develop a comprehensive overview of the variety of KMSs used by SMEs because of the tendency of the 29 articles to narrow their analysis to the use of a specific solution.

Cloud computing has been recognized as an important enabler for the development of such collaborative applications having the potential to increase knowledge management practices in SMEs (Schneckenberg 2009; Sultan 2013). More precisely, cloud computing has been considered as a great opportunity to improve project collaboration within the construction (Amarnath, Sawhney, and Uma Maheswari 2011; Jiao et al. 2013; Matthews et al. 2015; Rawai et al. 2013; Singh, Gu, and Wang 2011). Similar to CRM SaaS, numerous project management SaaS – such

as Basecamp, Jira, and Wrike – have received good feedback from thousands of small firms, which suggests a great value for workforce engagement within STEs, especially in the construction sector.

2.1.4. Cloud computing

As introduced in Chapter I, cloud computing is an on-demand shared pool of configurable computing resources that can be rapidly provisioned with a minimal management effort or service provider interaction (Mell and Grance 2011). This has led to the emergence of SaaS for every firm's domain such as ERP, CRM, project management, accounting, human resource management, etc…The three discussions about the digitalisation of operational processes, customer relationship, and workforce engagement have pointed out a real value of SaaS solutions for STEs. However small firms in construction, transportation, industry, and commerce sectors have shown slow adoption behaviours of cloud computing applications (Palos Sánchez and Deusto 2017). To conclude this literature review, an analysis of the studies focusing on cloud computing adoption within SMEs is necessary to complete our vision about potential enablers and inhibitors affecting STEs' digitalisation.

A few recent quantitative studies have assessed the key factors influencing the adoption of cloud computing by SMEs. Two articles proposing literature reviews on cloud computing adoption pointed out that most empirical studies had applied technology-oriented models to assess the key factors affecting cloud computing adoption (El-Gazzar 2014; Salah Hashim, Bin Hassan, and Salah Hashim 2015). Using this observation, a short comparison of recent empirical surveys that applied the TOE framework was performed to highlight the main findings. Table 4 sums up a selection of articles found through Google Scholar using the following keywords: technology organizational environmental, TOE, SMEs, and cloud computing adoption.

Table 4: Selection of empirical studies using the TOE framework to assess key factors for cloud computing adoption within SMEs

Reference	Study	Key factors
(Ramdani et al. 2009)	102 SMEs (Manufacturing, Retail, Real estate services) in the UK	Relative advantage, top management support, organizational readiness, firm size
(Low, Chen, and Wu 2011)	111 high-tech SMEs in Taiwan	Relative advantage, top management support, firm size, competitive pressure, and trading partner pressure
(Alshamaila, Papagiannidis, and Li 2013)	104 firms (74% SMEs in high-tech and others) in Greece	Relative advantage
(Hsu, Ray, and Li-Hsieh 2014)	200 firms (65% SMEs in ICT, manufacturing, services) in Taiwan	Perceived benefits, business concerns, and IT capability
(Oliveira et al. 2014)	369 SMEs (manufact-uring and service) in Portugal	Relative advantage, complexity, technological readiness, top management support, and firm size
(Hemlata Gangwar, Hema Date, and R Ramaswamy 2015)	280 firms (30% SMEs in IT, manufacturing and finance) in India	Relative advantage, organizational readiness, top management, training and education
(Hsu and Lin 2016)	102 firms (62% SMEs in finance, service, manufac.) in Taiwan	Relative advantage, security, financial costs, satisfaction with existing IS, and competition intensity
(Qian, Suhaimi Baharudin, and Kanaan-jebna 2016)	102 SMEs (Manufacturing and service) in Malaysia	Top management support
(Hassan et al. 2017)	132 STEs in Malaysia	IT resources and external pressure are significant.
(Kumar, Gandhi, and Verma 2017)	271 SMEs (roughly 70% are STEs) in India	Relative advantage, security concerns, top management support, external pressure and service providers' support

The comparison of the 10 articles points out technological and organizational factors as more important than environment factors – such as competitive pressure, external IS support, industry characteristics, and market scope (Hemlata Gangwar et al. 2015; Ramdani et al. 2009). In detail, relative advantage, compatibility, and complexity are the technological factors whereas organizational readiness, top management commitment, and education are organizational factors that are the most often cited as critical for successful cloud computing adoption, see Table 5.

However, most of the studies analysed SMEs' answers from the manufacturing and service sectors. The only two studies that had a sample that could be considered as representative of STEs highlighted the importance of environmental factors such as external pressure and service providers' support (Hassan et al. 2017; Kumar et al. 2017). Thus, it appears that the importance of the factors varies depending on the SMEs' characteristics. For instance, STEs seems more impacted by external pressure and support than medium firms in manufacturing. Furthermore, the lack of studies on cloud computing adoption by STEs emphasizes a need to lead research into this field.

2.2. Research questions

Through the review of the different streams of the SMEs' literature about ICT adoption, we were able to develop our perception about the current level of digital maturity of STEs. Digital maturity is a term often used by consultancy firms to assess the digitalisation level of their client. Four different levels are defined such as beginner, conservatives, fashionistas, and digital masters (Michael Fitzgerald, Nina Kruschwitz 2013; Westerman, Didier. Bonnet, and McAfee 2014). The fact that STEs have been rarely studied into the SMEs' literature suggests that researchers failed to find interesting case studies of STEs adopting digital solutions. For instance, the only article that discussed the digitalisation of the construction sectors were describing the potential benefits of cloud computing without having strong case studies to support their claims (Amarnath et al. 2011). Thus, STEs seems to hold the last position into the digital transformation race. Figure 5 discloses the different digital maturity levels according to the firm's sector. Our assessment of the level of STEs' digitalisation has been located in the bottom left corner of the beginners' square.

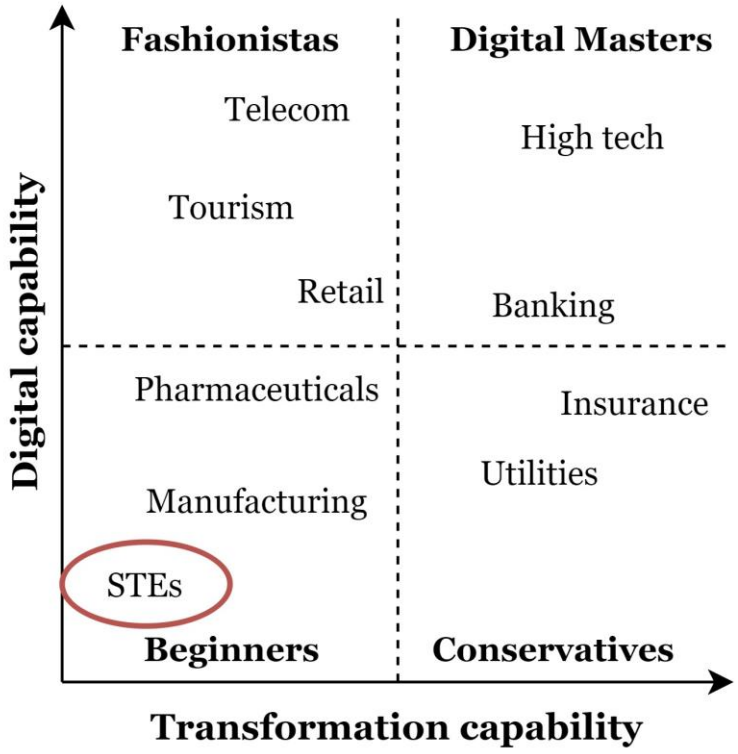


Figure 5: Comparison of the digital maturity of STEs and other sectors (adapted from Westermann et al. 2014)

The digital maturity matrix emphasizes the importance of transformation and digital capabilities. Ideally, STEs should enhance both capabilities to reach the digital masters' level. Regarding the insights obtained from our literature review, we point out several factors that are the causes of the low transformation and digital capabilities of STEs.

The review on ERP adoption emphasized the importance of directors as the main actor who should be convinced. Organizational and structural factors are often cited by directors as barriers for adoption. It has also been shown that researchers should distinguish between small and medium firms. For instance, only firms of 50 or more people generally consider ERP solutions. Finally, ERP adoption has mainly been studied in the manufacturing sectors, which raises questions about the value of ERP SaaS for STEs. Thus, until we can clearly establish its value, it is most unlikely that STEs will increase their transformation capability to adopt SaaS ERP.

CRM solutions, unlike ERP solutions, are important for every small and medium firm in any sector. Internal key factors for CRM adoption are similar to those

for ERP solutions. However, external factors such as pressure from clients or partners are also important. Furthermore, SMEs tend to adopt CRM without properly using customer data to harness their business with data-driven models. Thus, promoting SaaS CRM adoption within STEs could be a strong enabler to improve their digital capability. However, developing an adequate transformation strategy to grasp the value of the customer data remains unsolved.

The enhancement of workforce engagement through digital solutions has been attributed to the usage of collaborative solutions such as project management system or chat/messenger/forum applications often based on cloud computing. However, due to the diversity of these collaborative solutions, researchers should seek to develop a comprehensive overview of the different values and key factors related to their adoption.

The emergence of cloud computing has greatly simplified the development and spread of digital solutions. This has allowed small IT firms and start-ups to develop their own solutions. For instance, it is easy to find dozens of SaaS solutions from small firms that became well-known in less than 10 years; examples are Slack, Wrike, MailChimp, Shopify, HubSpot, and Odoo. These solutions have been designed for small enterprises and they can easily be tested for free. Slack aims to improve internal communication and workforce engagement, Wrike is a project management application that improves knowledge/information management, MailChimp is a web application for digital marketing, Shopify allows anyone to set-up an e-commerce platform, HubSpot is a CRM SaaS that improves customer relationships, and Odoo is an ERP SaaS that improves the management of resources.

Following this trend, small IT firms have started to develop specific solutions for SMEs in different sectors. In other words, the IT world has evolved from the idea that a solution should have many features to obtain a maximum of potential clients from diverse sectors. The aim is now the development of lighter solutions that focus on specific clients and sectors.

Based on the observation of these societal changes, two main assumptions are done about the current situation that STEs are facing into their digital journey.

1. We assume that the simplicity of SaaS solutions makes it easier for anyone to develop sufficient knowledge to adopt them. For instance, Shopify has a “drag and drop” interface that simplifies the creation and customization of an e-commerce platform. Thus, the lack of relative advantage or knowledge should no longer be a serious obstacle for STEs’ adoption.

2. The second assumption is based on the emergence of numerous small web applications on the Internet. Increasing the choice of solutions makes it difficult for SMEs with few resources to explore them and decide which one is most suitable.

However, the lack of resources among SMEs could be well managed because of the ease of testing the new SaaS solutions. Some of those solutions apply the business model called "freemium", which allows anyone the possibility to test the solutions for free, with a few constraints – such as a small space allowed for storage and limited access to the solution's features. If the new user finds the solution appropriate, they can start paying a monthly fee to gain access to more features and resources of the solution. This new business model offers opportunities for small firms to explore SaaS solutions without any cost, which should increase the relative advantage perceived. It also gives the possibility for external actors to test those solutions for SMEs.

Two main gaps were highlighted in this literature review. The first gap reveals a need to develop a comprehensive overview of the SaaS solutions available on the Internet and their potential benefits for STEs. Exploratory studies should focus on collaborative solutions for STEs, which have been neglected in the literature compared to studies analysing the adoption of CRM or ERP solutions by medium firms in the manufacturing and high-tech sectors. In a few years' time, it might be evident which solutions will naturally be adopted by STEs, which would provide interesting case studies for qualitative research. However, this current gap offers an opportunity to conduct experimental research to understand how to improve knowledge creation and transfer for STEs. In an age where digital transformation means interconnecting communities to improve knowledge transfer within society, an experimental approach to helping STEs learn about new digital practices seems pertinent.

Thus, a first research question defines the main guideline for the study presented in Chapter 3:

How STEs' digitalisation phenomenon could be efficiently enhanced?

The term " STEs' digitalisation phenomenon" stands for the global adoption of SaaS solutions by STEs. The choice of the word "efficiently" highlights the need to figure out approaches that would enhance the digital transformation of a majority of STEs. In other words, we are not looking at proposing the best approach to lead

successful digital transformations into STEs, but we are looking at the ones that might have the biggest impact on the huge STEs' community.

For the second research gap, it appears that studies about CRM, ERP, and cloud computing have generally identified the same enablers and inhibitors that affect ICT adoption by SMEs. However, it remains unclear how they affect each other. In addition, it is unclear how the government or other actors might help SMEs to develop the proper enablers to reduce the potential barriers. El-Gazzar (2014) drew two conclusions, which sum up the overall state of the literature about ICT adoption by SMEs. First, articles utilizing general concepts are predominant, as evident in the many surveys using the TOE framework. Knowing that organizational factors play an essential role, it is surprising that researchers remain focused on technology-oriented models. Instead, they could examine organizational theories affecting firms' transformation, such as absorptive capacity, organizational culture, intellectual capital, and dynamic capabilities. Applying these theories should build a better understanding of which intangible firm characteristics improve or inhibit STEs' digitalisation.

For instance, most studies on ICT adoption by SMEs have neglected the role of relationships, which in organizational theory are considered a key criterion for a firm's innovation. Thus, a second research question is proposed as the foundation of a mixed-methods study (discussed in Chapter IV):

What are the organizational factors affecting STEs' digitalisation?

The two research questions both add contributions to the literature on SMEs, regarding the digital transformation of STEs. Furthermore, the second research question should also provide findings to help answer the first question. Indeed, increasing our understanding of the organizational factors acting as enablers or inhibitors of digital transformation should help to define an efficient approach to enhance the STEs' digitalisation phenomenon. To conclude our research proposal, it is important to discuss the research context, which concentrated on local STEs in the French region of Switzerland.

2.3. Research context

The research focused on STEs in Switzerland that had 10 to 100 employees each. The choice research in this context was justified by two reasons. First, the action research was used to design a method to increase the relative advantage perceived regarding the adoption of new digital practices and the support of directors for such adoption. To maximize the chance of success of the action research, it was preferable to work with STEs close to the researcher's university, the Swiss Federal Institute of Technology in Lausanne. STEs that knew the university's reputation would be more motivated to participate and it would be relatively easy to conduct experiments with people who shared a national culture and mother tongue.

Second, Switzerland is in the top 10 countries with the highest GDP per capita in purchasing power. It is also in the top 10 countries with high ICT Development Index scores (Dillinger 2017). Thus, barriers such as financial constraints or access to proper ICTs for adopting new digital practices should have relatively little impact on small Swiss firms. In other words, they provided a sample to gather data on the importance of organizational factors, without being too impacted by environmental factors.

Switzerland had a total of 586 214 registered firms in 2016 (BFS 2016), of which 89% were micro-firms of fewer than 10 people. Micro firms were considered to be outside of the research scope. Although we were interested to understand how to foster new digital practices within small firms, micro firms were considered too small to be reliable cases for assessing organizational factors.

Among the registered firms in Switzerland, 60 052 were registered as SMEs or large firms. Small firms of less than 50 people represented 82.5%; 14.9% were medium firms (50–249 employees); and 2.6% were large firms. These partitions demonstrate the importance of small firms for the economy of Switzerland. Furthermore, the construction sector is one of the most important for small firms, with a fifth of them related to activities such as civil engineering, architecture, and building construction. The rest of the small firms are mainly in other traditional sectors, such as dealership, food industry, and catering services. Therefore, research to understand how to support STEs into their digital journeys might have important consequences for the future of the country.

The necessity of analysing this phenomenon has been understood by governmental agencies. For instance, a survey conducted in 2017 by the chamber of commerce in the Canton of Vaud revealed the situation of 388 local SMEs regarding digital transformation (CVCI 2017). A few interesting results are presented below to build an understanding of SMEs' current situations. The first question asked managers about their views regarding the level of information they were able to gather on digital transformation. Sixty per cent claimed that they did not have enough information on this topic, with 40% stating that they were not interested in it. Furthermore, the survey revealed that more than 80% used the Internet and information media (business magazines) as principal sources of information on this topic, and 42% also shared information by word of mouth. These statistics suggest that SMEs lack information on new digital practices, which might also explain the lack of interest among most of them. Using informal networks to learn about new digital practices and internal research reveals a lack of adequate support from governmental agencies or other associations.

The survey estimated the impact of digital transformation perceived by SMEs on their business. Half of the respondents perceived it as an opportunity; a quarter did not really know, and a quarter had observed negative effects on their business.

Table 5 sums up the objectives pointed out by 243 SMEs that had already started their transformations.

Table 5: Objectives of 243 SMEs that started digital transformations

Objectives	Percentage
Optimization, integration and automation of processes	21%
Information sharing	11%
"Zero paper" objective, digital archiving	11%
To remain competitive	10%
Marketing, visibility, social network	10%
Customer relationships, data client management	9%
Digitalisation of accounting process	7%
Other	21%

These results support the literature review presented earlier in this chapter about the tendency of SMEs to digitalize their operational processes and customer relationships. However, the survey did not reveal much insight into cloud computing and workforce engagement. As cloud computing has been defined as a positive opportunity for SMEs, it might be interesting to conduct another short survey about its adoption within the Swiss context. Furthermore, no previous studies using the TOE framework have explored the Swiss context. Thus, a survey was designed to assess the current situation of cloud computing adoption by STEs.

2.3.1. Preliminary observations

As discussed in the literature review, cloud computing is a term that everyone interprets in his or her own way. For IT experts, it is the foundation of shared configurable computing resources allowing the development of SaaS. For others, it is often considered as a basic way to store documents on a virtual space. Thus, it is important for the design of the two studies related to the two research questions, to deepen our understanding of the STEs' perception of cloud computing. A first objective of the survey was to gather data about the current situation of Swiss STEs regarding their adoption of cloud computing. A second objective was the assessment of the technological and organizational factors empathized into the SMEs' literature for the Swiss context. A third objective was to offer respondents the possibility to register to participate in the research presented in Chapter III.

At the beginning of the survey, a multiple-choice question described different states of cloud computing adoption, to assess the current STEs' situation. In the case of having already adopted a cloud solution, the company was asked to share the solution's name. The purpose was to establish a list of cloud solutions that might be used during the action research. Two other multiple-choice questions were then posed to evaluate perceptions about the benefits and barriers of using cloud computing. The choices listed in the two questions were selected from the literature review. The last part of the survey used items inspired from the organizational factors (top management support, organizational readiness, employees' skills) and technological factors (relative advantage perceived, complexity, compatibility) of the TOE framework. Table 6 lists the items of the survey adapted to the research context.

Table 6: Items assessing the organizational and technological factors affecting cloud solution adoption by Swiss STEs

Reference	Item
RelAd1	The employees think that cloud solutions are (will be) useful.
RelAd2	Cloud solutions (will) give us a competitive advantage.
RelAd3	Cloud solutions (will) allow us to innovate our business model.
Complex1	Learning how to use cloud solutions is easy.
Complex2	Knowing where to apply cloud solutions is easy.
Compa1	Cloud solutions are compatible with the IT infrastructure.
Compa2	Our data can easily be exported to the cloud.
TopMan1	We recruit competent people in the research and management of new information systems.
TopMan2	We allocate part of our financial resources to the implementation of new information systems.
TopMan3	Innovation through new information systems is a priority for top management.
TopMan4	Employees are rewarded according to their motivation to learn.
OrgRead1	The objectives are reviewed during group discussions.
OrgRead2	Employees feel confident enough to communicate.
OrgRead3	Employees help each other during structural changes.
OrgRead4	The hierarchy communicates regularly.
EmpSkill1	Employees know how to store and share documents on the Internet.
EmpSkill2	Employees know how to work collaboratively thanks to applications or programs running on the Internet.
EmpSkill3	They know how to automate tasks through the development of small routines (Excel macros, Google add-ons).

The survey was sent to an email list of 2511 SMEs located in the French part of Switzerland in September 2016. The email list was bought on the online directory Kompass.com. The email asked SMEs to answer the survey in the context of a doctoral study assessing the current state of cloud computing adoption by SMEs. At the end of the survey, the respondents could request a summary of the results to gain insight into other firms' situations. They also have the possibility to request an interview to discuss potential collaboration for research on digital transformation.

A total of 127 answers were collected and 79 answers were selected for the factor analysis. The 53 respondents removed were not considered as STEs. Among the respondents removed, 19 firms were from IT or high-tech sectors, 22 firms had fewer than 10 people, and 7 were medium firms having more than 100 people. Table 7 gives information about the classification of firms according to their sizes and sectors.

Table 7: Sector and size of the 79 STEs that filled out the survey on cloud computing adoption

Sector	Number	Percentage
Service	23	29%
Construction	20	25%
Industry	17	22%
Other	14	18%
Association	5	6%
Size (no. employees)	Number	Percentage
10-24	45	57%
25-49	22	28%
50-99	12	15%

The percentages of the firms' size and sectors correspond to those reported by the Swiss federal department of statistics, suggesting that the sample was representative of the population. However, to validate the reliability of the sample, we examined the partition of STEs regarding cloud solution adoption. Previous surveys have shown a low rate of adoption, around 10% for STEs (DESI 2018; Palos Sánchez and Deusto 2017). Table 8 shows the results obtained for the multiple-choice question assessing the current situation of the respondents about cloud computing adoption.

Table 8: STEs' situation about cloud computing adoption

Current situation of STEs regarding cloud solutions	*Percentage*
Use cloud solutions for more than one year	44%
Currently testing cloud solutions	14%
Trying to understand cloud solutions	13%
Not enough resources to look at cloud solutions	10%
Not interested	19%

Thus, most of the respondents had already adopted or were looking at cloud solutions for their firms. However, these results should not be considered as representative of the whole population of STEs, because of bias in the respondent profile. Indeed, STEs with an interest in cloud computing were probably more inclined to participate in this survey because of the potential opportunity to learn more about solutions adopted by others. The names of the cloud solutions cited by the respondents are summarized in Figure 6.

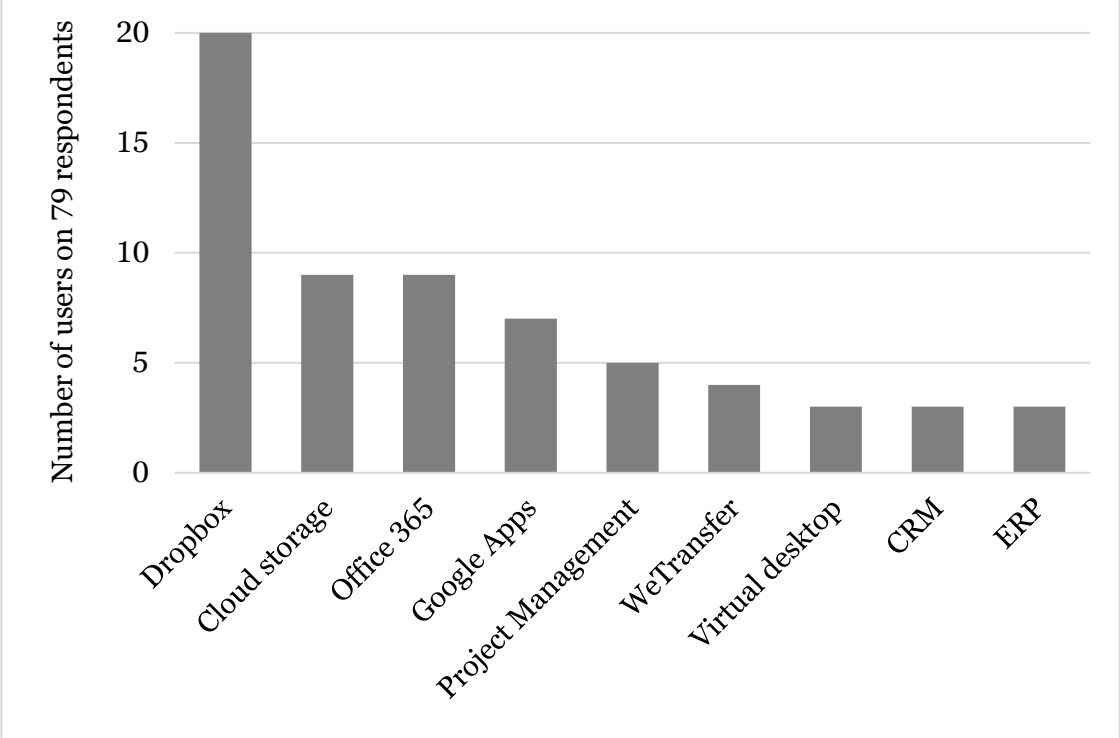


Figure 6: Categories or names of cloud solutions most cited by respondents

It is interesting to note that over the 55 solutions mentioned, 45 are related to basic usage of cloud computing, such as information storage and sharing. Only a few STEs named cloud solutions with business applications such as project management and resource management features. Thus, these results enhance the preliminary observations about the gap between available cloud solutions on the Internet and the current stage of STEs' adoption. They support the first research question about the need to define initiatives to increase STEs' awareness of opportunities provided by new SaaS solutions. They also support previous findings of the need to develop a comprehensive overview of the different SaaS solutions for STEs.

The next two multiple-choice questions assessed the benefits and barriers perceived about adopting cloud computing. Table 9 illustrates the results obtained for the benefits and barriers perceived by the 79 respondents about cloud computing.

Table 9: Benefits and barriers of cloud computing as perceived by 79 STEs

Benefits perceived	Percentage
Better access and usage of information	39
Better internal and/or external collaboration	13
Guaranteed update and maintenance of the services	10
Reduction of IT infrastructure costs	8
A possibility to innovate business model or processes	6
No benefit perceived	3
Barriers perceived	Percentage
Concerns about data security and confidentiality	38
Difficulties of integration with current systems	20
Lack of knowledge	18
The complexity of business processes	1
Others	1

It appears that the benefits perceived by respondents fit the solutions named in Figure 6. This lack of concrete evidence about the value of cloud computing to innovate business processes and to increase collaboration illustrates the importance of exploratory research to examine the benefits of complex cloud solutions. Complex

cloud solutions are web applications that aim to reshape business processes or services, unlike basic solutions for information sharing.

The second and third largest barriers were related to lack of proper knowledge about using and setting up a new digital practice. This finding also supports the need for initiatives to enhance the knowledge creation and transfer within STEs about new digital practices.

The second part of the survey assessed the technological and organizational factors related to the TOE framework. I was not able to perform confirmatory factor analysis on the data in this study because of poor results from the model fit statistics. The comparative fit index (CFI) of 0.82 did not reach the minimum acceptable value of 0.9; and the root mean square error of approximation (RMSEA) index was 0.088, which exceeded the upper limit of 0.06 for good models. However, Cronbach's alpha for the various factors was around 0.7; only the complexity factor was substantially lower, at 0.54. The alphas indicate that the item distribution per factor seemed reliable.

The fact that factor distribution seemed reliable, but data were not fitted to the model might be explained by dimensionality problems (Schmitt, 1996). Thus, exploratory factor analysis was performed to look for a better model. However, the same weak values for the model fit index were obtained, even after removing items with weak factor loadings and reducing the number of factors to resolve potential underlying multidimensionality. A reason for the inability to identify a correct model with the data might be that the sample of 79 STEs was too small (Isabel Izquierdo, Julio Olea, and Francisco José Abad 2014).

Because the main purpose of this survey was to develop a better understanding of the current STEs' situation regarding cloud computing, I decided to split the data into three sub-samples. These were grouped according to the firms' situation regarding cloud computing solutions. The first group was composed of firms that had adopted cloud solutions for more than a year; the second group was firms that had started to explore those solutions, and; the last were firms that were not looking at cloud solutions. Then, the average value of each item was calculated according to the different groups. As the factors showed adequate Cronbach's alphas, it means that the items can be gathered under their respective factors. Thus, the average values of the items have also been combined to provide an average value per factor. Table 10 shows the results obtained, which allow the comparison of the three groups per factors.

Table 10: Scores obtained for organizational and technological factors among three groups of 79 STEs (adopters, potential adopters, and not interested)

Cloud solutions	Not interested	Potential adopters	Adopters
Distribution	31.5%	25.9%	42.6%
Relative advantage (RelAd1, RelAd2, RealAd3)			
Score	3.0	3.8	4.8
Variation	0	0.8	1.8
Complexity (Complex1, Complex2)			
Score	4.0	4.2	4.9
Variation	0	0.2	0.9
Compatibility (Compa1, Compa2)			
Score	4.8	4.7	5.0
Variation	0	-0.1	0.3
Top Management (TopMan1, TopMan2, TopMan3, TopMan4)			
Score	3.4	3.5	3.9
Variation	0	0.0	0.4
Organizational Readiness (OrgRead1, OrgRead2, OrgRead3, OrgRead4)			
Score	5.3	5.0	5.6
Variation	0	-0.3	0.6
Employees' skills (EmpSkill1, EmpSkill2, EmpSkill3)			
Score	3.7	3.6	4.3
Variation	0	-0.1	0.7

The variations highlighted through the comparison per factor of the scores obtained for each group reveal interesting insights about the roles of organizational and technological factors in cloud computing adoption. For instance, the average values of the relative advantage and the complexity factors increased according to the level of cloud computing adoption. This is logical because cloud solution adopters are more able to perceive the advantages and have some know-how regarding usage, which reduces the complexity perceived. The overall high average value for compatibility suggests that STEs did not perceive the integration of cloud solutions into their structure as an issue. This finding seems contradictory to the second barrier listed in Table 9. Thus, attention was given to the compatibility factor during the mixed-method research on organizational factors affecting ICT adoption by STEs.

The results obtained for the top management and organizational readiness factors raised some questions about the impact of those factors on cloud computing adoption. The three scores for top management support were relatively low. This indicates that STEs did not consider cloud solution adoption as a priority in their business strategy. Thus, further research should look at the triggers that motivate STEs to adopt cloud computing, or, from a general perspective, SaaS solutions.

All three groups showed strong values for organizational readiness. In other words, STEs that did not adopt digital solutions still had a favourable culture to implement transformation. It would be interesting to explore this claim with qualitative observations.

Finally, the low scores for the employee-skills factor support previous findings about the lack of IT skills within STEs. The marked variation between the adopters and the others is logical, as adopters would have developed stronger digital skills because of their current use of cloud solutions.

The results obtained with this survey convey the fact that action research is necessary to define potential strategies to increase the awareness of STEs' top managers regarding digital transformation. Furthermore, although technological and organizational factors were highlighted as essential for cloud computing adoption, it remains unclear which antecedents of organizational factors would trigger the appropriate changes to start a digital transformation. This lack of clarity justifies the use of mixed-method research to develop a more detailed view of the relationships among the organizational factors.

Chapter 3.

An Open Innovation platform

Small enterprises in traditional sectors are not adopting new digital solutions such as SaaS, web applications, or basic cloud computing solutions even though the benefits could be important for their business process management (Palos Sánchez and Deusto 2017). As an explanation for this phenomenon, studies have pointed out lacks of top management support, relative advantage perceived, and knowledge as factors reducing the organizational readiness of STEs to adopt new digital practices (H. Nguyen and S. Waring 2013; Kumar et al. 2017). From this observation, the following research question has been established and provides the common thread of this chapter:

How STEs' digitalisation phenomenon cloud be efficiently enhanced?

The objective of this question is to define an approach that might have an impact on the digital transformation of a majority of STEs. Through a short discussion about the different strategies used by SMEs to enhance their innovation capability, the collaborations between students and STEs is defined as a potentially efficient method to increase STEs' digitalisation (Collinson and Quinn 2010). According to the literature on collaborations between students and SMEs, a second value of such collaborations would be the opportunity for students to train soft skills that are essential for the 21st century (Binkley et al. 2012; Peças and Henriques 2006).

The concept of a digital platform connecting master's students from engineering fields with STEs was designed to lead collaborative projects on the identification of opportunities for digital transformation. The value of the digital platform value and its design are established through a three-level analysis combining literature from open innovation, knowledge management systems, and organizational change management models.

Through a three-year study, two different design of platforms were tested with a total of 39 projects performed. This important number of projects provides a strong dataset to assess the effect of students' collaboration on STEs' digitalisation.

3.1. Research design

The overall objective of this chapter is to define an efficient method to increase STEs' digitalisation. An efficient method stands for the necessity to have a maximum impact on the whole STEs' community for a minimum cost. The need to look at efficient method over effective ones comes from the huge number of STEs that are still at the square one of their digital journey (DESI 2018).

Lack of knowledge has been highlighted as an important barrier to STEs' digitalisation, which could lead to experimental research about designing training programmes to develop digital skills among STE employees (HTW Chur 2019). However, the lack of knowledge about digital skills in the STE context makes this idea impractical. Furthermore, it has been shown that program run by universities to provide training and education do not improve the innovation capability of SMEs if they are not custom made for each participant (contrary to usual course design) (Macdonald, Assimakopoulos, and Anderson 2007; De Saá-Pérez, Díaz-Díaz, and Luis Ballesteros-Rodríguez 2012).

From this observation, literature has highlighted the importance of external actors to support SMEs (Berry, Sweeting, and Goto 2006). Caputo et al. (2002) propose an interesting methodological framework for innovation transfer to SMEs. They define three elements reducing innovation diffusion within firms such as:

- High cost related to innovation activities;
- Fear and aversion to changes consequences; and
- Modest information about public or private incentives to innovate.

Additionally, they argue that these three elements are stronger within STEs because of the modest financial resources and knowledge they own and the little time the director may dedicate to innovation activities. Finally, they suggest the potential of other actors than consultancy firms to support STEs such as academic or R&D departments of big companies. They highlight the reluctance of STEs to look at consulting services because of the cost perceived as too high for leading a pilot project to assess the value of new technology. Furthermore, STE directors tend to claim that consultants lack the specific experience about the firm context, while consultants are arguing that directors are too focused minded on small issues without looking at the big picture (Christensen and Klyver 2006).

Even though the cultural divides between academia and industry is a stereotype well established, studies about different collaboration designs highlighted some successful cases (Bjerregaard 2010; Chung and Wong 2002). For instance, Collinson and Quinn (2010) highlighted the value of students to support SMEs growth by providing useful assistance to identify business needs, by being flexible to change the project scope, and by updating participant's knowledge with new ideas. Furthermore, Peças and Henriques (2006) define best practices to improve the successfulness of collaborative project between students and SMEs on process innovation such as:

- a focus of the project on a specific, localized issue;
- where the potential of improvement is large;
- and a clear definition of the role of SMEs' participants.

The primary objective of this chapter is to define an efficient method to increase STEs' digitalisation. Collaboration with students seems to have the potential for this task. Furthermore, the yearly turnover of students provides a significant workforce that might have a great impact on the STEs' community. In a digital environment where STEs lack the resources to explore and understand all the new SaaS solutions, collaborating with students might be an interesting alternative. It could allow STEs to maintain a certain level of awareness about digital opportunities. A concept of a digital platform to connect students and STEs on small projects about digital transformation was conceived to test the real value of such initiative. Additionally, a new question arises about:

What is the value for academia and STEs to collaborate on projects about digital transformation through a digital platform?

The question empathizes the potential of the digital platform to have different values depending on the perspectives of the actors involved. From an STE perspective, the platform aims to provide an easy way to get support for the research on digital transformation opportunities. It also aims to train STEs' digital skills on a collaborative online solution. From a student's perspective, it might have a significant impact on the creation of adequate knowledge to lead a project, which will assist in the development of essential skills for their future job such as communicating, collaborating, learning to learn, and creativity (Binkley et al. 2012). Finally, from an

academic perspective, the digital platform might be considered as a shift from classical teaching practices to a student-centred learning approach. Jahnke (2009) wrote a nice article about the potential of collaborative solutions similar to the platform to reverse "the traditional teacher-centred understanding of learning [by] putting students at the centre of the learning process and letting them participate in the evaluation of their learning." Thus, the teacher becomes an expert, coach, consultant or facilitator depending on the situation. Furthermore, the platform might even involve other actors such as consultants or governmental agencies. Thus, the research will not only assess the value of students supporting STEs but also the potential of the platform to support/innovate activities of each stakeholder.

To design the platform, a three-level framework has been established (see Figure 7). From a conceptual level, the concept of the platform is evaluated through the lens of open innovation strategies to look at its feasibility. Knowledge management literature is presented as the theoretical background to assess the level of success reached by the collaborations hosted on the platform. Finally, a selection of change management models such as Business Process Models, the Absorptive Capacity model, the Results Pyramid, and the Value Proposition Canvas is introduced as the tools applied on the platform to enhance the collaborations and knowledge creation between students and STE directors.

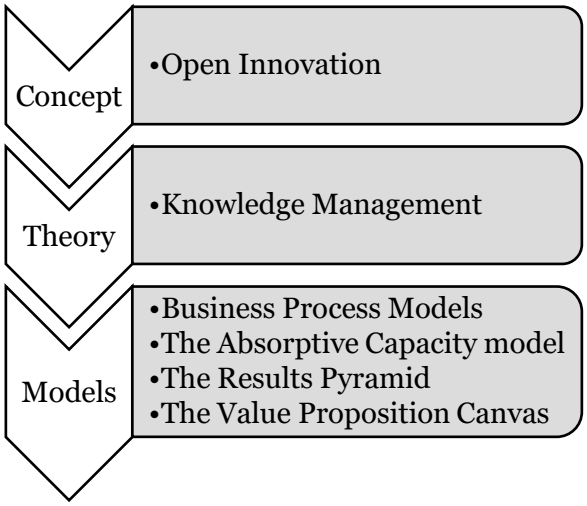


Figure 7: A three-level framework for designing a digital platform to connect students and STEs, for collaborative projects on digital transformation

3.1.1. Open Innovation

According to the new definition given by Chesbrough and Bogers (2014), open innovation represents "a distributed innovation process that involves purposively managed knowledge flows across the organizational boundary". Open innovation is a term that gained attention as digital transformation in the last decade. Trott and Hartmann (2009) stated that open innovation was followed tacitly by companies even before the first explicit definition was proposed by Chesbrough (2003). Nonetheless, the current popularity of the term attests to societal change, with companies generally seeking to enhance their innovation capability. Analysing this phenomenon, the literature on open innovation within companies has been well established (West et al. 2014).

Recent research on the role of intermediaries – such as university incubators, living labs, and open innovation platforms – has highlighted the need for research on new strategies and designs to enhance open innovation processes in diverse communities (Katzy et al. 2013). Frey et al. (2011) pointed out the importance of intrinsic motivations to bring diversity to platforms such as InnoCentive and Atizo. However, these studies were focused on open innovation strategies for product innovation. A typical challenge for these communities was to target and motivate members with the right skills for specific product innovation to participate.

To my knowledge, the literature before this study did not include projects to connect students who lacked experience in digital transformation with STEs for projects on business process innovation. This study explored the value of such an initiative to enhance STEs' awareness of digital transformation opportunities. In addition, this action research adds to the literature on open innovation applications.

Through their review of 51 articles, Hossain and Kauranen (2016) highlighted several gaps regarding open innovation studies with SMEs. First, more than half the articles were quantitative studies using surveys. These surveys were assessing the percentages of firms involved in open innovation strategies and the impact of those strategies on their innovation performance. However, only a little attention has been paid to open innovation strategies where firms are only participating and not managing the open innovation initiative.

Second, studies tended to analyse the impact of open innovation strategies for high-tech SMEs only. For instance, Brunswicker and Vanhaverbeke (2015) analysed SME behaviour toward open innovation; they used a large dataset from a European

survey. They showed that only technology-oriented SMEs were intensively collaborating with universities. I argue this is true only for open innovation initiatives concerning product innovation. In contrast, this chapter explores the issues arising from the collaboration between a university and STEs for process innovation.

Third, there is a need for researchers to understand the factors that mediate outcomes of open innovation initiatives. The digital platform is an open innovation initiative fostering the creation of new knowledge between students and STEs. A short discussion about knowledge management theory is necessary to outline the potential risks, barriers, and challenges that could occur during the creation and transfer of knowledge between students and STEs on the platform. Thus, the results should provide insights into the factors mediating the outcomes of such an initiative.

Last but not least, this study fits the agenda research addressed by Perkmann and Walsh (2007). That is, studies should explore collaboration processes between universities and firms and should investigate the organization and management of those relationships.

3.1.2. Knowledge Management theory

The knowledge management literature has received much attention from researchers since the end of the 1990s. The dawn of the new economy, based on high-velocity marketplaces, pushed large firms to examine the optimization of their innovation capability with knowledge management practices to stay competitive. However, the knowledge management literature regarding SMEs did not get the same level of attention from researchers. Furthermore, most of the articles focus on the knowledge management within SMEs, without considering the possibility of creating a knowledge management system (KMS) managed by an outsider – such as academia. Thus, general definitions of knowledge management are applied to the current research context. This facilitates the discussion of a new research design for knowledge management experiments.

Gold et al. (2001) demonstrated the importance of seven knowledge capabilities to improve organizational efficiency. These were separated into two categories: the knowledge process and knowledge infrastructure capabilities (see Figure 8). The knowledge process is composed of four capabilities, namely acquisition, conversion, application, and the protection of new knowledge. The knowledge

infrastructure is composed of three capabilities, namely technology, structure, and the culture within a firm.

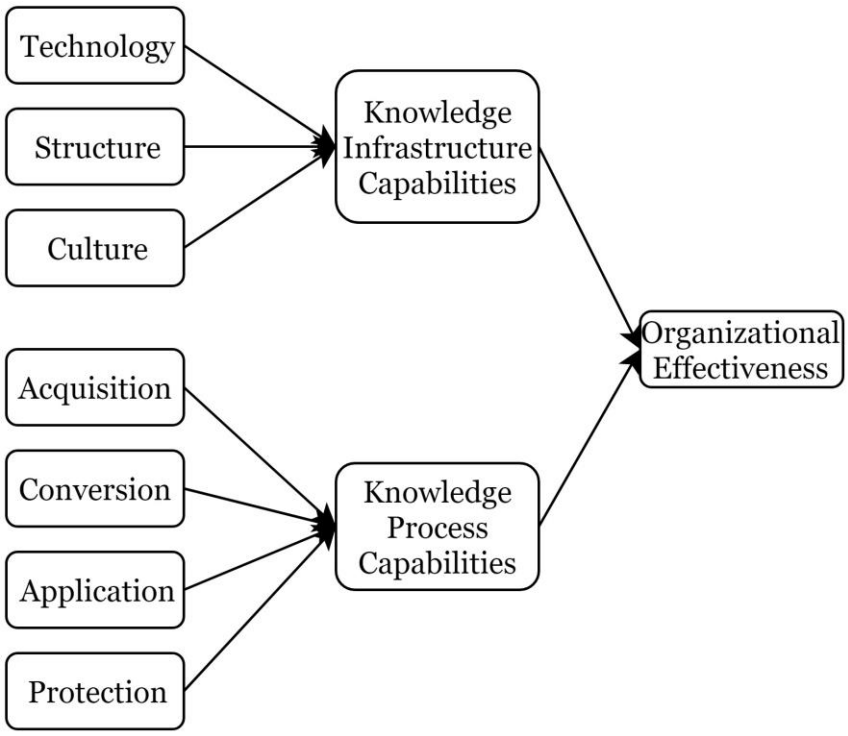


Figure 8: Knowledge management capabilities (Gold, 2001)

Each of these capabilities plays an important role in the success of any knowledge management system. Thus, a discussion about the three dimensions of knowledge infrastructure will allow perceiving the major challenges present in this research.

1. The technology that impacts knowledge management is often viewed as crucial for sharing and storing knowledge. However, it includes other dimensions that are less discussed in the literature, such as its potential for business intelligence, distributed learning, knowledge discovery, knowledge mapping, and opportunity generation. As explained earlier, a comprehensive overview of the SaaS solutions with a potential value for STEs is needed. Thus, the digital platform will not only be assessed on its capacity to store and share knowledge, but also on its potential of using all the knowledge generated to create knowledge mapping and distributed learning.

2. The literature on the organizational structure to foster adequate knowledge practices gave insight about the appropriate structure for the research design. For instance, the optimization of knowledge sharing within a small team can lead to a decline in knowledge sharing across the firm as the efforts are allocated at a smaller level., To apply this advice to the research, efforts should not only be focused on improving collaboration between students and STEs. A part of the efforts should also foster collaboration among the students to share experiences, ideas, and solutions.
3. Finally, organizational culture has been defined as the most significant hurdle to effective knowledge management. As previously discussed, interaction and dialogue between people are essential for knowledge creation. The organizational culture is defined by the values, beliefs, and vision shared among employees of a firm. This topic was not adapted to the research context as students and STEs' participants only worked together for a short period, which made it difficult to establish a strong common culture. However, it remains interesting to assess the cultural traits of students and STEs that foster or hinder knowledge activities.

    Furthermore, one key characteristic of a good organizational learning culture is the empowerment of employees to self-organize their work and have enough time to develop networks to seek solutions to problems. While it might be complicated for STE directors to let this kind of freedom to their employees, the project plan applied by students will give them enough flexibility to self-organize their work. Two other critical cultural factors were the trust and openness of STE participants towards students' input. As it was difficult to improve these factors without having previous insight regarding the students' value perceived by STEs, a secondary purpose of this research was to assess these factors during the projects. Potential solutions to manage them were sought.

    From an overall perspective about knowledge infrastructure, discussion of the technology, structure, and culture revealed important insights that helped in analysing the platform's performance. A discussion about the four knowledge process capabilities is also crucial for developing a deeper understanding of the process underlying the collaboration between students and STEs.

1. Acquisition of new knowledge is also defined in the literature as knowledge creation. This capability has received the greatest interest from researchers. Nonaka (1994), in his famous dynamic theory of organizational knowledge creation, defined interactions between individuals as the foundation for knowledge

creation. To illustrate this knowledge-creation process, Nonaka proposed the "SECI" model – referring to socialization, externalization, combination, and internalization. These are four activities leading to the creation of either tacit or explicit knowledge within a company. According to Desouza and Awazu (2006), STEs tend to rely solely on socialization to increase their knowledge. Thus, STEs seek informal face-to-face meetings for transferring tacit know-how between individuals, instead of codifying and combining explicit knowledge within knowledge management systems.

To propose solutions to STEs, students will have to go through the four activities. The internalization will be useful for students to acquire and codify the STEs' situation. Then, the combination activity is crucial for defining an adequate solution. Students will have to externalize the tacit knowledge acquired about the solution to present it to STEs. Finally, students and STEs will be involved in a socialization activity to discuss the solution. As an attempt to explore the ability of STEs' participants and to aid the students to understand the project's context, it will be requested from participants to externalize their tacit knowledge about the firm's situation.

2. Knowledge conversion is the capability to integrate, structure, coordinate, and distribute knowledge; it can also be called knowledge-transfer capability. In this research, it is crucial to understand how to improve knowledge transfer between students and STEs. A key element for managing this capability is the design of the digital platform.

   Szulanski (1996) explains that impediments to transferring tacit knowledge between a trainer and trainee within a firm are as follows: a lack of absorptive capacity in the trainee, causal ambiguity, and an arduous relationship between the two people concerned. Arduous relationship is between the source and the recipient of the knowledge. Lack of individual absorptive capacity arises through difficulties of the recipient to institutionalize the usefulness of the new knowledge. Causal ambiguity occurs when barriers to knowledge transfer are unclear.

   To manage these potential challenges, modelling methods are required. They will help students and STEs to develop a common vision of the project's situation, which will reduce causal ambiguity and improve the absorptive capacity of recipients. The arduous relationship is a delicate factor as the researcher lacks the power to force proper collaboration by the STEs. One option is to develop a pleasant environment with an easy-to-follow method to foster STEs' participation.

3. Knowledge application is a capability that received less attention from the researchers. The common assumption that led to this oversight was that once a firm has gained knowledge and realised its value, it can use that knowledge effectively. Knowledge application can be defined by activities such as effective storage and retrieval mechanisms. The digital platform should support the application of new knowledge by STEs. An STE participant should be able to easily retrieve a solution proposed by a student and share it with other employees. A tutorial with explanations about the use of the solution within the firm should be clear enough to allow any employee to start using it.
4. Knowledge protection in the research context is delicate to handle. STEs have to share information about the current state of their internal processes with students to allow them to look for potential optimization. This request could produce resistance and concerns about information leaks. Thus, a non-disclosure agreement will be signed by students, and the platform structure will provide a private virtual workspace for students and STEs to ensure confidentiality in the analysis, models, and tutorials.

   From an overall perspective about knowledge process, a literature review by Durst and Edvardsson (2012) conclude with the need for future research to explore the domains of knowledge identification, knowledge distribution, and knowledge application within SMEs. Based on these observations, the research attempts to design a digital platform to foster these knowledge activities within STEs. The use of methods and models should improve the knowledge process between students and STEs. Thus, a list of different methods and models is presented to be applied by students to lead their projects.

3.1.3. Change Management models

The action research was performed over six iterative loops lasting six months each. During the resulting three years of research, different methods and models were progressively integrated into the digital platform. This section presents the methods and models chosen and their possible effects on knowledge processes. The reasons for their application during the research are discussed further in this chapter through the description of the six loops.

Nonaka and Takeuchi (1995) suggest that organizations defined by a non-hierarchical, self-organizing structure facilitate knowledge creation. Following this

idea, the research design fostered these dimensions within the projects. Agile management approaches were used to allow some freedom for students to organize their projects. In addition, the objectives of the students to obtain a good grade for their projects were independent of the project's success. They were evaluated on their ability to properly analyse a situation, design appropriate solutions, and maintain records of their progress. The fact that their grades did not depend on feedback from STE participants avoided entering into a type of hierarchical structure.

Business process models (BPMs) are well known in the consultancy world as the tool to use for modelling a firm's current situation – called the "as-is" process. Then prototypes of "to-be" processes are proposed to the client as optimizations using new IT solutions. The method described in *BPMN Method & Style* was used as guidelines by students to draw the internal processes of STEs (Silver 2011). A good BPMN should follow four principles, namely completeness, clarity, shareability between STEs and students, and structural consistency. As example appears in Figure 9.

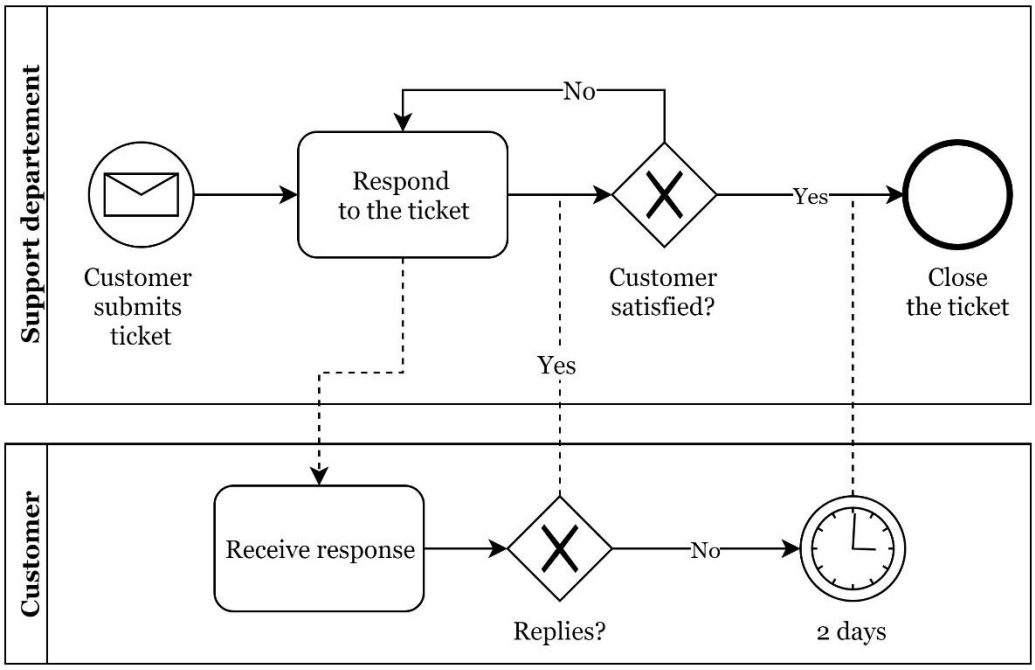


Figure 9: Example of a Business Process Model

Furthermore, a social BPMN approach will be used to improve the clarity and reliability of the process represented (Brambilla, Fraternali, and Vaca 2012). It consists of embarking STEs in collaborative activities of process modelling. Asking STEs to be involved in this activity is a good indicator of the participant's motivation

to perform knowledge codification with students. Thus, using BPM methods will bring various benefits to the projects. It will allow 1) students to grasp the STEs' situations, 2) researchers to map the knowledge by comparing STEs' situations, 3) researchers to assess STEs' motivation to engage in knowledge identification.

A framework added to the platform in the middle of the action research was the value proposition canvas (VPC). Its role was to help students and participants to connect the STEs' needs and digital solutions' values. The VPC was originally designed to help businesses to clearly establish the value proposition of new products and services by highlighting the ties between clients' needs and solutions' features (Alexander Osterwalder et al. 2014). The canvas is composed of two sides: the solution and the users' perspective (see Figure 10).

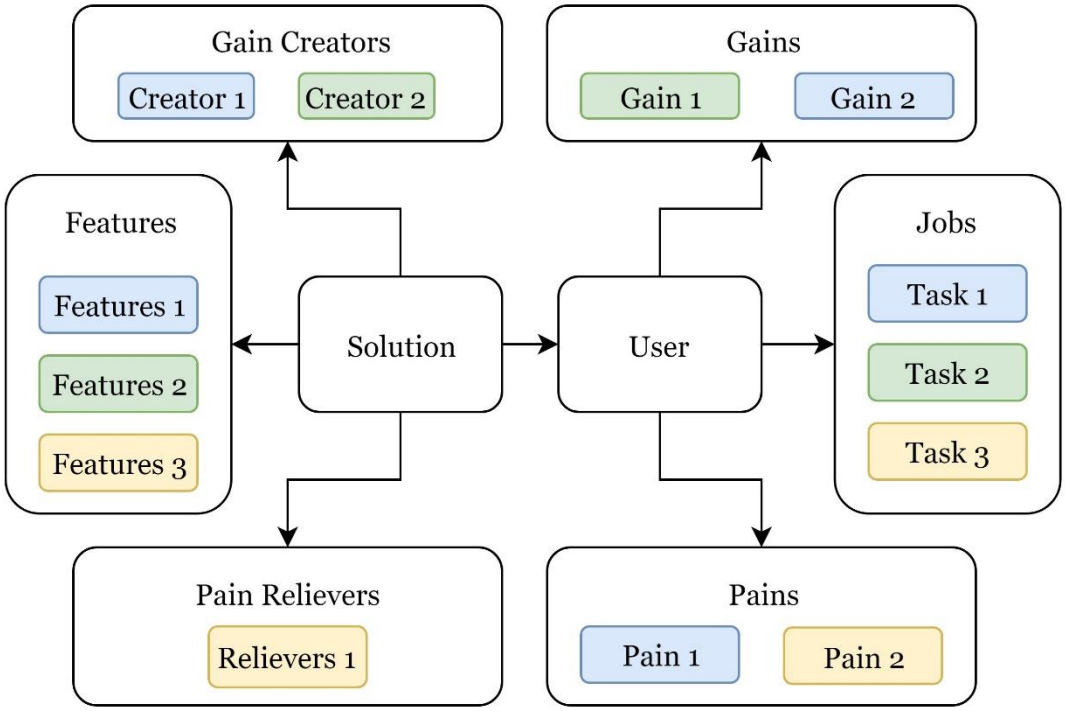


Figure 10: Value Proposition Canvas from Osterwalder et al. (2014)

The students and participants started by defining the different tasks from the user that had potential pains that could be reduced or potential gains that could be improved. Then, students looked for a solution on the Internet that might relieve a maximum of pains or create a maximum of gains for the user. This model was added after a discussion with students about their difficulties in clearly establishing the projects' requirements with STEs.

The application of BPM and VPC aimed to increase the STEs' awareness about the value of digital solutions. It helped to create a common vision between students and participants to motivate them to test new digital solutions and train their digital skills. However, another purpose of the research was to look at methods to increase the leadership capability of STE managers. The absorptive capacity model was the first model chosen for this purpose. Gold (2001) highlighted the necessity for every firm to develop adequate absorptive capacity before even thinking about learning new knowledge. Zahra and George (Zahra and George 2002) defined absorptive capacity as "a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability." Following this definition, Lane and Koka (2006) proposed a model pointing out the antecedents affecting the absorptive capacity of firms (see Figure 11).

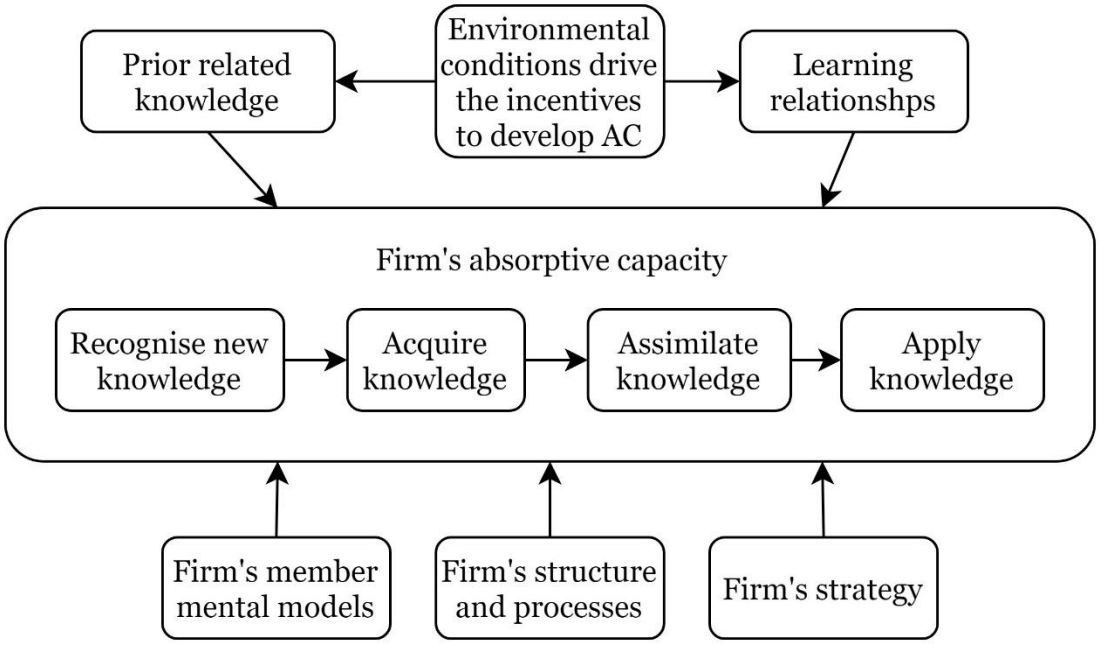


Figure 11: Absorptive capacity model proposed by Lane and Koka (2006)

Applying this model during the projects fostered reflection between students and STE managers about the current state of organizational factors, which might act as barriers for the adoption of a new digital solution. If the application of this model succeeds, it could be used as a guideline for STEs' managers for enhancing leadership capabilities.

A final framework used during this research was the results pyramid proposed in *Change the culture, change the game* by Connors and Smith (2011). This framework was introduced in the middle of the research to gather more data on the organizational culture of STEs. Unlike the absorptive capacity model, which offers an overview of the organizational factors involved in adopting new knowledge, the results pyramid focuses on values and beliefs that act as barriers. Connors and Smith (2011) analysed organizational culture through four levels: results, actions, beliefs, and experiences. Each result is the consequence of an action; each action was triggered because of specific beliefs, and; these beliefs were based on previous experiences. Figure 12 shows an example of the application of the results pyramid.

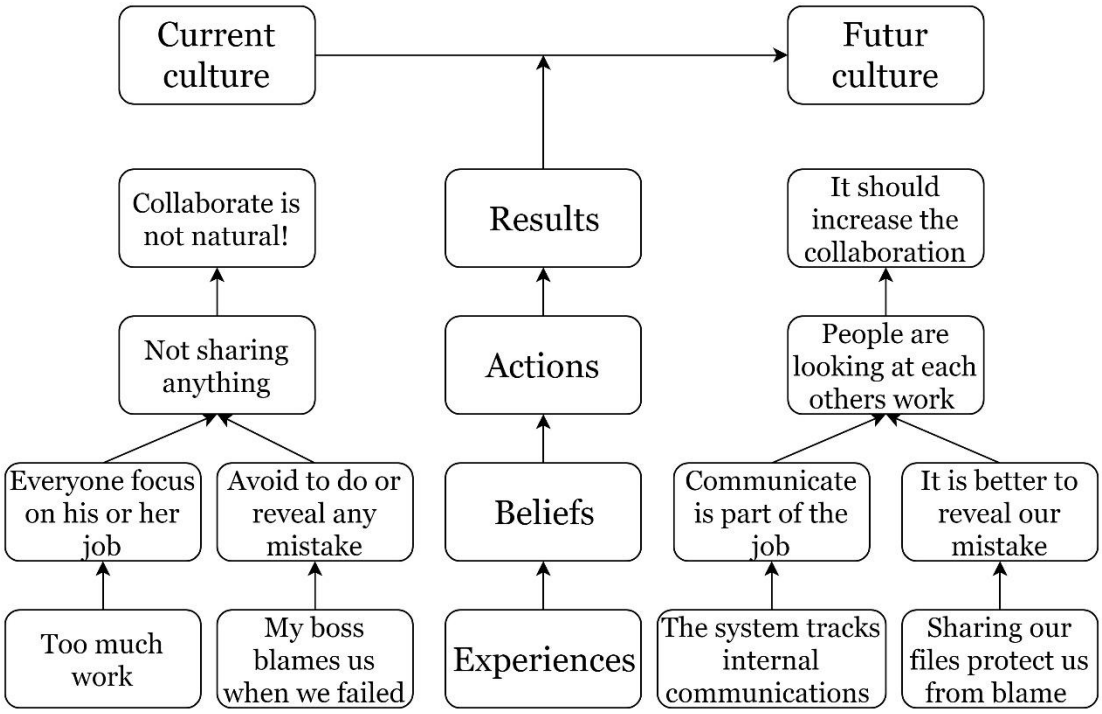


Figure 12: Result Pyramid framework by Connors and Smith (2011)

The short description of different methods, models, and frameworks helped to build our understanding of the elements involved in designing the research. To conclude the chapter on research design, a short discussion about the constraints imposed by the academic structure and the methodology applied during this research is necessary.

3.1.4. Constraints

To fully understand the structure of the action research, a detailed description of the academic and professional contexts is required. This highlights the environmental constraints and opportunities that impacted the research and led to certain research choices.

An initial challenge was the short period allowed to run a collaborative project between a small business and a student. The project plan had to fit within an academic semester; education standards split the studies into two semesters of 14 weeks each per year. For instance, it was impossible to design a project over a year with the same student working for a small business on specific process optimization. Students were not allowed to perform two similar projects during their studies.

Given this constraint, three academic formats were available for the collaboration between master students and STEs. The collaborations could be designed as a project within a master course, as a semester project, or as a master's project. Integrating projects into a master course would mean designing 14 weekly courses on process optimization and digitalisation, with an assessment based on the projects' results produced by teams of students. The difference between a semester project and a master project was the weekly time allowed. A master project offered the opportunity for the student to be fully dedicated to the project over the 14 weeks, whereas a semester project was a project performed alongside other master courses, with a time allocation from five to 10 hours per week.

The decision to design the projects as semester projects instead of integrating them into a course or proposing master's projects was taken for various reasons. The first was uncertainties about STEs' structure and behaviour. For instance, medium and large enterprises usually have complex processes to optimize, which would produce enough data for a master project. However, the risk of insufficient material for a student to work on STE business processes full-time for 14 weeks was considered high. Thus, concern about the simplicity or the lack of established processes within STEs convinced us to favour the structure of a semester project over a master project.

Secondly, the initiative of seeking collaboration with STEs for digital transformation projects was new within the university. Hence, the unpredictability about the number of STEs that would participate for the semester required flexibility about the process of selecting the appropriate number of students. With a master course, it would have been challenging to ensure enough projects for a class of

approximately 50 students, as there was no previous experience regarding how many STEs would participate.

The collaborations were designed to be integrated into a semester project of 14 weeks. The relevant period was March to June or September to February. The number of hours per week allowed for a semester project differs according to the students' courses. For instance, mechanical engineering students must dedicate a day per week for a semester project, while civil engineering students dedicate only half a day per week. Overall, each student should allocate 70 to 140 hours to a project, which is quite short to conduct a project.

A second constraint was the recruitment of students from specific fields to conduct collaborative projects with small businesses. As a PhD student working for the chair of Logistic, Economic, and Management, I was able to propose semester projects to students doing their masters studies in mechanical engineering, civil engineering, or management. To enrol enough students, two methods were tested. The standard procedure for recruiting students was to submit project descriptions on a private web platform managed by the university and open to students. Students could directly register for the projects on the platform. However, the use of this platform was neglected by students from certain fields, such as mechanical engineering. Therefore, an email was sent at the start of each new semester to a class of approximately 200 students, who were registered for master courses called "project management and risk analysis" or "logistics and demand analysis". The project was presented as a study about analysing and seeking opportunities to optimize a process in a small business using web applications or SaaS solutions found on the Internet.

3.1.5. Methodology

In the book *Engaged Scholarship: Creating Knowledge for Science and Practice*, Van de Ven (2007) underlined the general growing concerns about academic research becoming less useful for solving practical problems, especially in management. One reason is the difference between the modes of knowledge production used by academia and the applied nature of management. For instance, Van de Ven describes management research within social sciences as equivalent to engineering research within physical sciences.

Bradbury (2015) defines action research as "a democratic and participative orientation to knowledge creation. It brings together action and reflection, theory and practice, in the pursuit of practical solutions to issues of pressing concern." The aim of the research presented in this chapter fits this definition.

Gummesson (2000) defines action research in ten major characteristics. We will discuss their appropriateness within this research.

1. *Action researchers take action*. The projects presented in this chapter would never happen without the research. Furthermore, the design of the digital platform is an action aiming to improve the collaborations during the projects.
2. *Acton research always involves two goals: solve a problem and contribute to science*. As previously discussed, the research aims to resolve the issue about the lack of knowledge from STEs about new digital skills. The contribution to social science lies in the assessment of the potential value of the digital platform as a new field for the literature on open innovation and SMEs.
3. *Action research is interactive*. A close co-operation between STEs, students and the researcher/developer will produce continuous adjustments of the digital platform and project plan.
4. *Action research aims at developing a holistic understanding*. The involvement of many STEs and students on the digital platform will provide information about essential characteristics to lead successful collaborations.
5. *Action research is fundamentally about change*. Even though projects are aiming to foster change within STEs, another main change supported by the digital transformation is a new way of teaching/training students' soft skills.
6. *Action research requires an understanding of the ethical framework, values and norms of the research context*. As I was a master student graduated for a few years, I was sharing common values with the students. Furthermore, face-to-face meetings and on-site visits will be planned to establish the project scope between the students and the STEs that are willing to participate. It should help to improve the general understanding of STEs' values and norms.
7. *Action research can include all types of data gathering methods*. One secondary objective of the digital platform is to explore different approaches to gather data on STEs. Students will apply management models to analyses firms' situation. They will provide weekly reports about their interviews and progress. Finally, I will lead group meetings or interviews to validate the insights.

8. *Action research requires a breadth of pre-understanding of the corporate.* Fortunately, STEs have usually simpler organizational structure than large firms, which reduce the importance to have a strong pre-understanding of STEs.
9. *Action research should be conducted in real-time,* which is the case in this research as I will apply agile management approaches to lead the projects and develop the platform.
10. *The action research paradigm requires its own quality criteria.* Action researchers should demonstrate (Coughlan and Coghlan 2002):
    a. the quality of the co-operation with participants;
    b. the quality of the iterative reflection justifying the change or improvement;
    c. the conceptual-theoretical integrity through the analysis of the learnings from different perspectives;
    d. the engagement of the research in a significant work;
    e. the sustainable changes that come out of the projects.

Thus, the research followed the action research process of conducting iterative loops to design a practical solution to enhance STEs' digitalisation (Stringer 2007). Each loop was composed of the "Look", "Think", and "Act" phases (see Table 11). The "look" phase was conducted during course semesters while students were leading their projects through the platform. At the beginning of the semester, a sub-research question was framed to focus clearly define the objective of the semester. Even though the main objective was to enhance STEs' digitalisation through the collaboration with students, each loop had its own sub-research question such as "Is virtual collaboration efficient?" or "How to empower students?". Data from observations, face-to-face and group meetings, online surveys, and project reports were collected to move into the second phase. The "think" phase was an activity of collaborative reflection to develop our understanding of the results obtained during the semester. It was done with semi-structured interviews with different stakeholders to analyse the results of the projects and review the challenges encountered. The learnings were listed, and suggestions of actions were defined for the next phase. Using those learnings, we identified priorities about changes to implement in the "act" phase. During this three-year experiment, 37 students worked with 39 firms from various domains unrelated to high-tech fields, such as manufacturing, services, and the building industry. 35 STEs had between 10 and 100 employees with a median of 40. Four firms were exceptions with a size of more than 100 employees.

Table 11: Description of the six loops that composed the action research

Loop n°	Look (3 months)	Think (1 month)	Act (2 months)
1 spring 2016	3 students / 2 organizations	Projects' reports, observations, debriefings with students during the projects	Design of a first platform
2 autumn 2016	5 students / 4 organizations	As 1st loop + 3 interviews to validate insights	Improvement of the first platform
3 spring 2017	5 students / 8 organizations	As 1st loop + 6 interviews	Design of a second platform
4 autumn 2017	4 students / 7 organizations	As 1st loop + 6 interviews	Improvement of the second platform
5 spring 2018	9 students / 10 organizations	As 1st loop + 8 interviews + weekly surveys filled by students	Improvement of the second platform
6 autumn 2018	11 students / 8 organization	As 1st loop + 9 interviews + weekly surveys	Highlight suggestions for further research

Using the methodology and research design established in this section, the realisation of six iterative loops allowed testing two platforms design to assess our assumptions about the students' values, to foster knowledge-management activities within STEs. The presentation of these six loops is centred around the test of the two platforms. The comparison of the two designs will produce important findings about the true value of this initiative to enhance STEs' digitalisation, academia-business collaboration, and innovation of teaching practices.

3.2. Pilot study (1st loop)

This first round was considered the pilot study. It aims to provide preliminary results about the potential of a digital platform to connect academia and small firms for process digitalisation.

3.2.1. Settings

The first round of the action research was conducted without the use of a platform. This round was essentially a pre-test for the following question:

Can students and STEs find mutual value to collaborate on a small project about digital transformation?

The round involved three master students in micromechanics, namely Amaury, Leonard, and Cyril. The two small organizations were a local newspaper with 50 collaborators and an NGO with 10 salaried employees. The three students were conducting projects of 10 credits, which represents 1.5 days of work per week, per student. Thus, the student workforce available for performing the analysis of two small organizations seemed enough. It was decided that the three students would work together on the two projects.

Although the two projects followed a similar methodology, a few small differences in the STEs' expectations should be discussed. The NGO's director wanted to improve the internal process efficiency of the organization. The idea was therefore to interview two key employees who could help the students to produce a detailed analysis of inefficient processes, such as communication with local beneficiaries and management of volunteers. Then the students would research potential cloud solutions on the Internet. At the end of the project, students would interview the rest of the employees to present their solutions and improve the overall perception of the NGO about cloud computing.

The interest from the newspaper arose from an urgent need to find innovative ways of increasing its revenues. However, the directors wanted to keep a certain control of the project. They also wanted a broader view of the firm's processes with suggestions for major improvements instead of focusing on specific task optimization.

However, the project plan followed by the students was similar for both projects. The plan was a first attempt to adapt a classic consultancy approach to STEs' context (Feind-Just 2014). It was composed of five phases:

a. Application of BPM to map the As-Is process during the first interview. It should help the student to visualize the firm's situation.
b. Sharing the process models with the STE participants; wait for feedback. It should help to avoid misunderstanding.
c. Research solutions to simplify the current processes with a special focus on web applications.
d. Creation of the new To-Be BPM, integrating the solution within the company. It should enhance the STE's awareness about the key benefits of the solution.
e. Sharing the To-Be BPM, with tutorials of the solution, with the STE participants; wait for feedback.
f. Return to "c." if necessary.

A Google site was set up to create a prototype of a KMS. Its purpose was to facilitate the transfer of knowledge among students and organizations. The overall idea was that students would create Google documents to share with the organizations through the Google site. In those documents, the students would import pictures and dynamic links of BPM designed on the web application Draw.io. The organizations would be able to comment on the picture or open the model to make changes to the BPM if necessary. The objective of this prototype was to pre-test the value of a platform to improve knowledge sharing between students and STEs. As previously discussed in Chapter 2, three pitfalls that might deteriorate the collaboration between students and STEs' participants are a lack of absorptive capacity from the participants, causal ambiguity, and an arduous relationship. Using a website as a common space to share documents should avoid causal ambiguity and help the researchers to empathize the causes of potential conflicts.

One constraint with the Google application eco-system (Google Site and Docs) was the need to have a Google account to access the collaborative features. Fortunately, the two organizations had already created Google accounts as they were using Gmail as their email application.

3.2.2. Overview (look)

The students succeeded in designing different processes for the NGO, such as project selection, humanitarian trip registration, and thank-you letters. As the NGO was already using Gmail, the students decided to explore the Google application environments to propose optimization. Google Docs application was presented as a solution to improve the collaboration for setting up projects with local beneficiaries in developing countries. A combination of Google Spreadsheet, Google Forms and a web application for sending emails (called YAMM) was presented for improving the humanitarian trip registration and management of volunteers.

From the NGO's perspective, the solutions proposed by the students were well accepted. The participants were quick to test them, and the director was strongly motivated to integrate the solutions into his daily routines. He was even motivated to lead a second project for the next semester with new students.

From the newspaper's perspective, a few constraints related to contextual and organizational factors impacted the project's results. First, the firm was already using specific systems to design the daily news. The systems proved to be too specific and the students were not able to test alternatives or explore them to look for optimization. Second, the firm was in a delicate phase of restructuring, which caused a high workload for every employee. Thus, directors were reluctant to ask their teams to test students' ideas about potential optimizations. For instance, a recurrent problem was poor management of email distribution, which caused communication issues between the teams working on different shifts (morning, afternoon, or night). A solution to differentiate important communications from external emails would have been the use of a profession chat application such as Slack. This solution was validated by the directors, but they did not want to launch a phase test.

3.2.3. Learnings (think)

As a conclusion for the first round, the differences observed between the two collaborations provide important learnings for the next loop. Furthermore, the observations and feedback collected during the various meetings with students and organizations indicated a few important points that strengthened my motivation to continue the research.

First, the two students were pleased to have the opportunity to practice business-process modelling skills for real processes, and they were able to devise concrete solutions. This supported the assumption that students would be able to test and explain new web applications. Second, students and STEs found the opportunity of collaborating valuable, although concrete results about the adoption of the solutions remained uncertain. For instance, the newspaper directors asked to attend the project's presentation by the students. This indicated that although they were not convinced about the students' solutions, they acknowledged their work. Third, directors from both organizations were open-minded and quite enthusiastic about the collaboration, from the beginning to the end of the project. Finally, a few other observations produced interesting learning that helped me to plan several actions for the next round (see Table 12).

Table 12: Learnings from the first loop

Learnings	Recommendations
The few video-conference calls were perceived as a valuable alternative to face-to-face meetings.	*It might be interesting to see if students can still be efficient if they have to manage a full project through video conferences.*
The NGO tried to collaborate to do the BPM; however, they struggled to manage the Google Site and the process modelling tool.	*A more flexible solution to perform collaborative process modelling activities is required.*
The workload was too light for students. They were a bit bored by the project when the firms were not enough responsive.	*Either students should work on more projects, or the interaction interface should be improved to build up the STEs' motivation to participate.*
The delicate situation of the newspaper firm heavily impacted the pace of the project.	*A pre-assessment of the firm's situation, with a first interview led by the supervisor, would help to assess the viability of a project.*

3.3. First platform (2nd loop)

The second loop started with the design a first prototype of a fully customized platform that will facilitate STEs access to students' work. This design resulted from the observations of the first loop about the STEs' difficulties to interact with students through the Google site. Another benefit of developing a platform was the possibility to assess the value of different platform designs for the collaboration between students and small firms. Furthermore, being able to create a home page using professional web designs would give a better first impression when a small firm visited the platform to submit a project. Thus, the platform would have different roles. It will showcase an easy way for STEs to get support from students and then it will aim to improve collaborative activities such as business process modelling.

3.3.1. Design (act)

One of the main challenges was to enable students and STEs to conduct real-time collaboration through business-process modelling activity during interviews. This requirement comes from the idea that students might train STEs' participants to practice knowledge codification activities. The objective was that students should help STEs to improve their understanding of potential process optimization through the application of BPMN. A second requirement was to create a flexible collaborative business process modelling environment to give the freedom to students and STEs to structure their projects. It is related to the advice given by Nonaka and Takeuchi (1995) about the importance of flexibility and freedom on knowledge creation. Furthermore, social applications such as a chatbox and a link through a video conference application were integrated for two reasons. Firstly, it will allow centralizing all the information produced and exchanged between stakeholder on one platform, which could lead to an interesting database for further research. Secondly, it should ease the communication between STEs and students and offer an easy way to find back previous information.

Figure 13 shows five screenshots of the platform. In the centre of Figure 13, the main view of the platform gives an example of a process performed with the BPM tool. The upper part of the figure shows the sub-menu to manage the models and users. The bottom part shows the video-conference and chatbox applications. The arrows highlight how to access the different features from the main page.

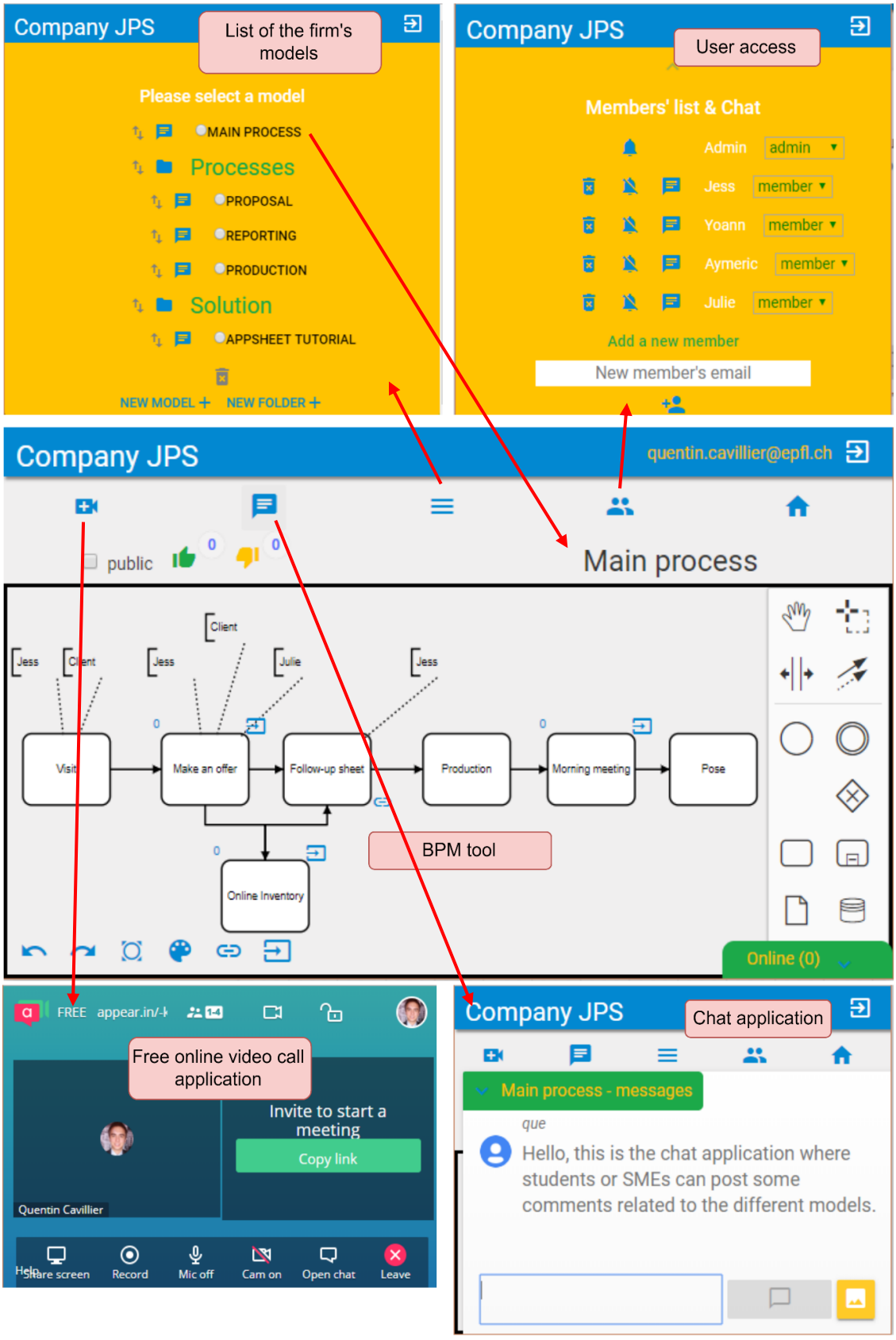


Figure 13: Screenshots of the first prototype of the platform

Two cloud computing infrastructures were explored for developing the platform. First, WordPress software was tested. WordPress is a well-known content management system allowing editing and alteration of the appearance of a website using a drag-and-drop approach, without having to modify any line of code. A strength of this software is its open-source approach with a strong developer community. Thus, a vast library of plugins is available to customize and add features to a WordPress website. Its popularity is demonstrated by a third of websites on the Internet being WordPress sites.

The second system tested was the Firebase platform proposed by Google. It aims to offer a cloud computing environment to quickly set up web or mobile applications by proposing a reliable backend system. The platform offers features to manage the application deployment and its database, such as user access, security rules, hosting of the frontend code, and storage of the files.

Unlike WordPress, Firebase requires coding skills to develop the frontend part of a web application. However, WordPress also requires some coding skills in specific situations. In the case of plugin customization, it is necessary to have strong programming skills to access different parts of the plugin code. For instance, I encountered considerable difficulty when I attempted to modify a WordPress plugin because I wanted to modify the functions for users' management. In this situation, WordPress becomes more complex to use than Firebase because of the need to master the full structure, frontend and backend, of a web application. This criterion was the first one that identified Firebase as a better choice than WordPress.

A second criterion was the discovery of the open-source repository BPMN.io (Camunda 2019). This open-source repository shares the code of a business process modeller tool with documentation to customize it. From my research, I did not find any similar tool with such developer modelling features. I tried to combine it with WordPress and Firebase systems, with successful integration for the latter.

Therefore, the first prototype of the platform was built with the Firebase system and it looked like a collaborative business-process modelling web application. It provided a private working space for a student and STE participant to collaborate on BPM. In addition to the collaborative BPM tool, it had chat and video-conference functionalities to allow virtual collaboration.

3.3.2. Settings

The second round started with an email sent to the list of 2511 STEs, introducing the survey (see the pilot study in Chapter 2). At the end of this survey, STEs had the option to register for an interview with myself to discuss potential collaboration with a student on the platform. Eleven companies expressed interest in a potential collaboration, with three accepting collaboration after a first interview, which I conducted. This selection followed the recommendation made in the first loop about a pre-assessment of the firm's situation.

The NGO that participated in the first round wished to continue working with new students on other topics. Five students registered for semester projects of 10 credits. They were allocated depending on the workforce needed for each project. For instance, the NGO wanted to test different solutions with three collaborators. The students Cedric, Sebastien, and Yoann were allocated to this project to act as personal coaches for each collaborator. Table 13 describes the different projects with their objectives and the firms' characteristics.

Table 13: Project descriptions of the 2nd loop

N°	Name	Sector	Size	Project topic	Students
1	Npa	NGO (involved in the first loop)	10	Project management	Cedric, Sebastien, Yoann
2	Efb	Electronics manufacturer	20	Email marketing, client feedback process	Aymeric, Philippe
3	Bap	Construction	50	Resources management	Cedric, Philippe
4	Jps	Construction	10	Client management process	Yoann

The purpose of the second round was to strengthen the observations about the students' value of collaborating with STEs on process digitization. However, a few new issues were also assessed in this round: 1) the value of using a BPM platform, 2) the feasibility of leading a full project through video-conference calls, and 3) the involvement of STEs to participate in modelling activities. These objectives for the round can be summarised under the general following question:

Can we lead the same approach through a digital platform with virtual collaborations?

The methodology for the projects was similar to that described in the first round. Interviews were scheduled every two weeks through video-conference calls. Interviewees were generally key people in charge of the main business processes, which allowed students to quickly grasp the whole functioning of the company. Then the students sought and presented potential solutions found on the Internet to the various participants.

3.3.3. Overview (look)

For this "look" phase and the next fourth, a table provides an overview of the results obtained during the projects. It will facilitate the comparison over the loops. The rows of the table are highlighted either in green, yellow, or red, depending on the project's success. The projects highlighted in green are considered successful, based on the ability of the student to propose an appropriate solution and acknowledgement by the firm of its usefulness. The projects in yellow obtained good feedback about the project's usefulness but they failed in the adoption phase. The projects in red were those that failed to demonstrate any kind of usefulness from the firm's perspective. Table 14 sums up the different results obtained for the four organizations.

From a general perspective, the four organizations validated the value of the students to propose valuable solutions. However, the results obtained for the testing and adoption phases were different. For instance, the company Jps did not have the time to test any solutions, with half of the interviews cancelled because of too much work. Furthermore, even though the director of Bap was full of compliments about students' work, the project stagnated in the testing phase because of a lack of reactivity from the testers chosen by the director. By contrast, the organization Npa was strongly involved in the modelling and testing phases of the various solutions proposed by the students. Unfortunately, they were not convinced about the solution proposed by the students. About the company Efb, only the sales manager was involved in the project. As he was really motivated by finding solutions to enhance customer relationships, students were able to conduct long interviews that produced detailed models of potential solutions.

Table 14: Results of the 2nd loop

Name	Solution	Result	Observation	Quote
Efb	Sending emails using Word and Excel	Adopted by one person	Only three collaborators are using ICT solutions to manage projects and clients' requests; others are in production.	"The student came up with great ideas, but I need more time to work on it."
Npa	Slack and Raklet	Tested but not adopted	Mixed feelings about using collaborative tools to manage volunteers and local partners in developing countries.	"Doing the modelling activities is not really useful for me."
Bap	AppSheet is a work time tracking app	Validated but not tested	Having live demonstrations of solutions from a student motivated the senior director to look for change.	"Doing this project was the trigger to change."
Jps	AppSheet as an inventory app	Validated but not tested	Solutions proposed were interesting, but the benefits perceived are uncertain.	"I'll be able to check our stock when I meet my clients"

The achievements obtained with the organization Npa are presented to illustrate a project considered as successful. First, students were able to interview three collaborators from the organization regularly. They conducted 14 interviews to produce five business process models and two tutorials of solutions. Figure 14 shares screenshots of the project performed on the platform.

In the middle of Figure 14, a screenshot shows a menu gathering all the models under the folders "solutions" and "processes". The screenshot above is the "Big Picture" model, which gives an overview of the connections among the employees and the various business processes. From the "Big Picture" model, blue icons at the top-right of process boxes are links to open detailed views of those processes, as shown for the "Project Management" process.

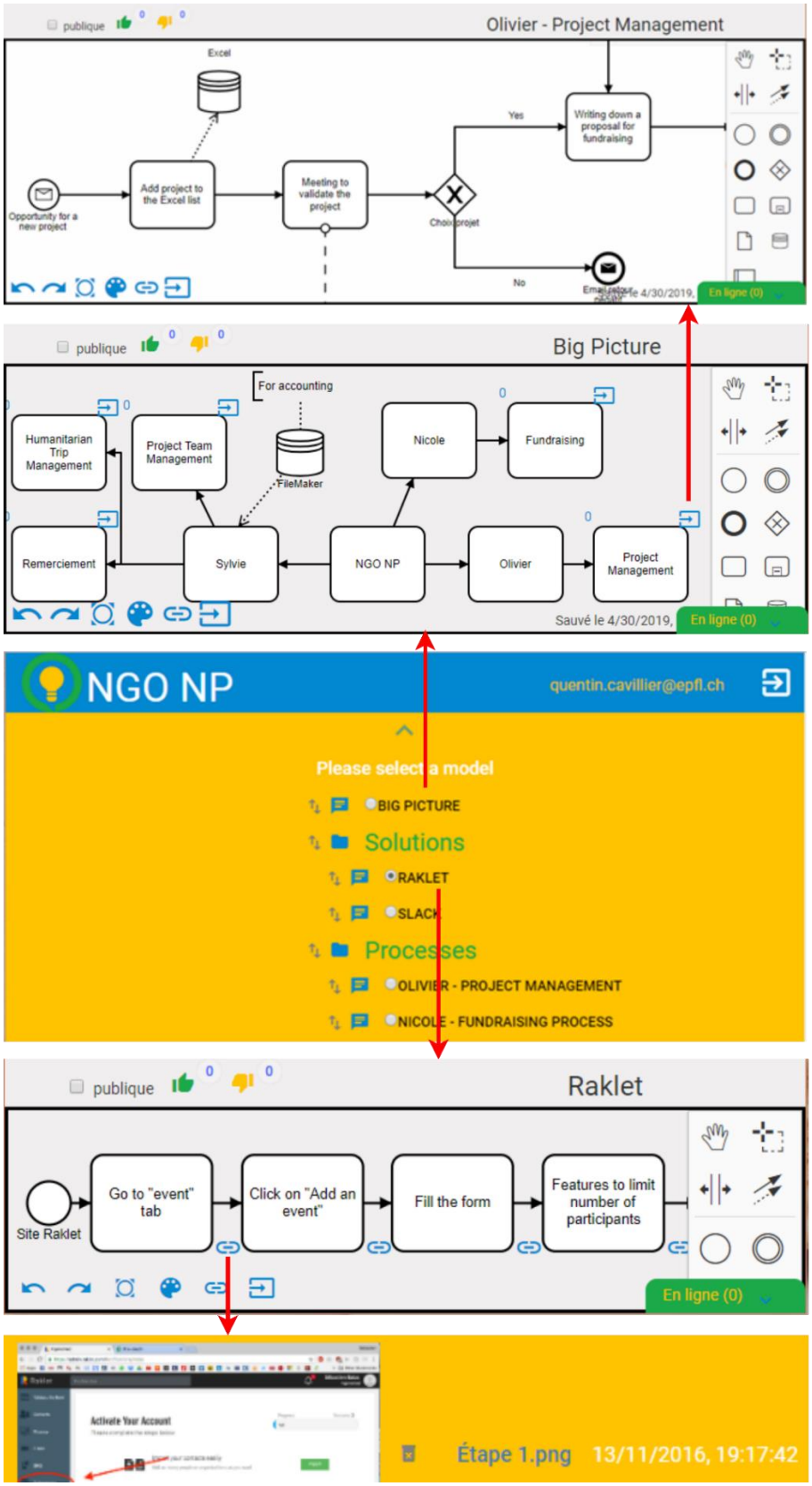


Figure 14: Example of a project performed on the 1st platform

The two screenshots at the bottom of Figure 14 illustrate a tutorial of the Raklet solution made by a student. The tutorial was designed as a process with each task needed to set-up the solution. He then attached a screenshot to each task representing the action to perform.

3.3.4. Learnings (think)

Debriefings with students and STEs revealed five major points that led to changes in the methodology for the projects.

First, the flexibility of the platform caused difficulties for STEs to interact with students. STEs did not take the time to explore the platform to understand the different features. Thus, the platform design should be improved to facilitate the retrieval of key points by participants. A dashboard will be added to gather all the knowledge and analyses produced by the student in one place.

Second, the analysis of the whole system of the company was not perceived as useful for the organizations. A participant of the organization Npa said, “We understood the value for the student and his project to do the complete analysis, but we already had good insights about what should be improved.” Furthermore, students showed some disappointment because of this low involvement from STEs in this analysis. Thus, the scope of the project will be defined before starting the collaboration.

Third, students felt a bit lost about how they should progress in the project and asked for a more structured project plan. This observation suggests that too much freedom given to a student will negatively impact the path of the project. Thus, even though the projects are relatively small, and they focus on a specific business process issue, students still need a method to structure their work. The PDCA method was chosen to be integrated into the dashboard, which should clarify the direction to follow by students.

Fourth, making tutorials with screenshots was perceived by students as inefficient because of the low involvement from the STEs to test the solution and the difficulties in operating on the platform. However, it is essential to figure out a solution to offer STEs’ participants a method to present the solutions to other collaborators.

Fifth, the director of Npa explained that "involving colleagues in the project before being sure to adopt the solution was perceived by the people involved as a possible waste of time". Thus, it seems better to restrict the collaboration to one representative per STE until a solution is chosen.

Table 15 sums up the learnings of this round and the actions to improve the collaborations of the next one.

Table 15: Learnings from the 2nd loop

Learnings	Recommendations
STEs did not take enough time to use the platform.	*Use a dashboard to facilitate the follow-up from organizations.*
STEs are not motivated to analyse their business processes.	*Focus the project on small process improvement.*
Students needed much support to make decisions to lead the project.	*Integrate a more structured method to lead projects on the platform.*
Tutorial with screenshots is time-consuming and not really useful.	*Ask students to make custom videos to present solutions.*
An STE director did not see the value of involving more than one participant in the analysis of the situation.	*The collaboration will start with one representative per STEs.*

To conclude this second round, it appears that STEs acknowledged the virtual collaboration with students. However, students felt disappointed because of the low motivation from STEs to test their solutions. To answer the question for this round, virtual collaborations seemed as efficient as face-to-face collaborations when STEs were closely involved. Leading more projects with different levels of on-site and virtual collaboration should provide more insight.

Overall, the platform demonstrated its ability to offer a flexible working environment for performing detailed business-process modelling activities. As an anecdote supporting this claim, a student asked for permission to use this tool to upload and attach articles to boxes in a model for drawing a map of a literature review, which he was conducting for his master thesis in the next semester.

3.4. First platform (3rd loop)

The third loop started with a few minor changes about the general plan that students were expected to apply to lead projects on the platform.

3.4.1. Design (act)

As discussed in the learnings of the previous loop, a new template model called "Dashboard" was automatically added when new projects were set up. It described the different phases of the Plan-Do-Check-Act (PDCA) method. Figure 15 represents the dashboard that students had to follow and complete during projects. Its purpose was to offer a clear project plan for students and a central model with all the information for participants. It was planned that each student should conduct two interviews to complete a phase, representing a total of six interviews per project. Furthermore, the new project plan would require the participation of only one STE collaborator. Overall the question of this round was focused on assessing the potential improvement of STEs' participation on the platform through the application of a more structured project plan:

Does the dashboard increase STEs' participation on the platform?

The "Plan" phase defined the project's objective, drew the current process model (called "As-Is") that was to be optimized, and analysed the firm's context using the absorptive capacity model. An initial difference compared to the last round was the definition of specific objectives to narrow the process modelling activities to one process instead of attempting to draw the whole functioning of the firm. A second difference was the attempt to use the absorptive capacity model proposed by Lane and Koka (2006). Its purpose was to highlight potential contextual barriers before seeking solutions. The student had to prepare an interview to complete the absorptive capacity model. At the end of the "Plan" phase, the student had to submit at least three videos introducing different solutions. The firm's participant had to select one to move to the second phase.

The main objective of the "Do" phase was to deepen the solution's features and define a scenario for testing the solution with a small team. The scenario was designed by the student and validated by the firm's participant. Instructions to set up the

solution and the scenario were presented through a video sent to a small team. The student acted as technical support for the team during the next two weeks.

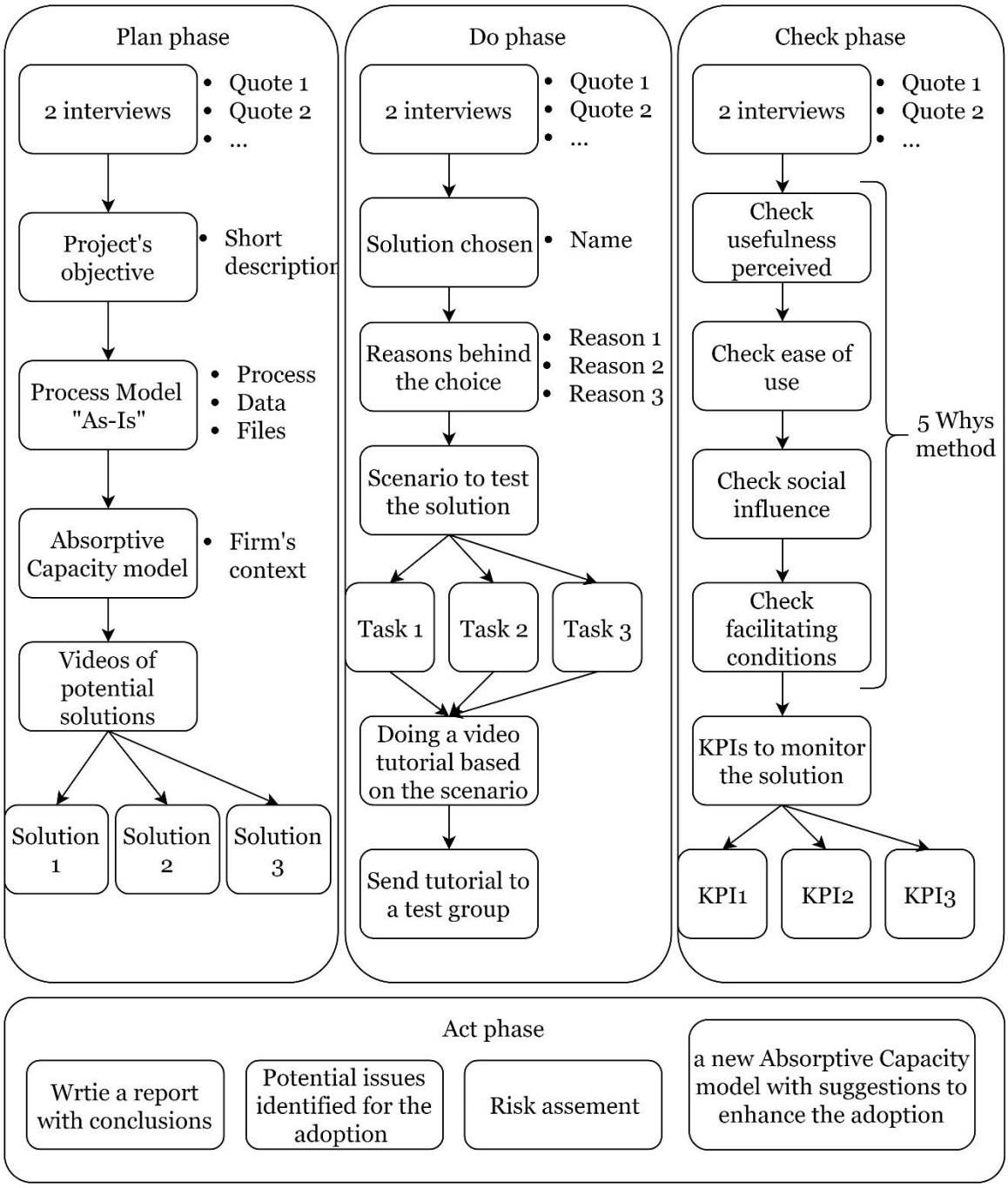


Figure 15: Dashboard added for the third loop based on the PDCA method

The “Check” phase was dedicated to gathering feedback about the solution. Different criteria assessing the readiness to adopt a new technology were selected from the Technology Acceptance Model (Venkatesh and Bala 2008). They were used to examine the root causes that might slow down the adoption. At the end of this phase, a list of key performance indicators was proposed by the student to monitor the success of adopting the solution.

For the “Act” phase, the student had to write a report about the key features that the solution should have and propositions for improvements. A new absorptive capacity model concluded the project by summing up the impacts of the solution on the different contextual factors of the firm.

A last major difference from the previous round was the step back to a more classical linear approach instead of trying to conduct iterative loops. Students were asked to go through the Plan-Do-Check phases and write their conclusions as propositions of actions for the Act phase. This choice came from previous observations about the students’ and STEs' difficulties in performing a real test within only two months.

3.4.2. Settings

The method used to contact local firms was similar to the previous loop. An email was sent to the same email list. However, the email only introduced the opportunity to collaborate with a student without asking people to fill in a survey. A document attached to the email was also describing the project plan and the requirements such as the weekly workload to provide by the STE participant (see Appendix 1). Thirteen STEs asked for a first interview to assess the value of potential collaboration, and eight STEs confirmed their interest to participate.

Only four students were recruited to conduct a semester project on the platform, with two of these students enrolling for 4-credit projects. The number of students was insufficient for the number of projects. I thus additionally accepted a student for a master project of 30 credits; she was in charge of the more complex projects. Table 16 describes the different STEs with the projects objectives and the students’ assignments.

Table 16: Project descriptions of the 3rd loop

N°	Name	Sector	Size	Projects topics	Students
5	Sie	Energy services	80	Project management	Adrien
6	Rit	Construction business	70	Task management	Elizam
7	Tap	Construction business	80	Client follow-up	Babak
8	Amd	Insurance advisor agency	40	Client information reporting	Robin
9	Aau	Automation industry	50	Project changes tracking	Robin
10				Client's visit management	Yue
11	Cis	IT consulting	80	Employees engagement on an internal social platform	Yue
12	Mbg	Waste management	65	Client reporting	Yue
13	Vic	HR consulting	50	Client platform	Yue
14				Client satisfaction process	Adrien

With twice the number of cases compared to the last round, this round was a good test for validating:

- the value of virtual collaboration using the platform;
- the value of the dashboard to increase STEs' involvement on the platform; and
- the general level of STEs' involvement during the projects.

3.4.3. Overview (look)

Table 17 sums up the results, observations, and quotes gathered in this round. It also lists the solutions proposed by students for the various projects.

Table 17: Results of the 3rd loop

Name	Solution	Result	Observation	Quote
Ala	Event Temple, Google Maps	Adopted	It was easy to test the solution because only the salesman was concerned.	"The student did an amazing job."
	Trello	Validated, but not tested	The manager understood that he wanted to improve the current solution in use.	"This project forced us to take the time to think about improvements."
Vic	Typeform	Adopted	Even if the project was a success, the student was not motivated.	"We will use the solution in the near future."
	SharePoint	Partially tested	The student struggled to define concrete improvements on the current SharePoint platform.	"Having a student interviewing our collaborators supported our willingness to change."
Rit	Trello	Tested but not adopted	Lack of support from directors to promote the test with a small team.	"Old technicians prefer to only use the email box."
Tap	Kissflow	Tested but not adopted	Value of the solution recognized but lack of time to test it.	"The student revealed the crux of the problem."
Mbg	Asana	Validated, but not tested	The manager wanted more time to discuss the solution with his colleagues.	"The tutorial video is great to identify the value of the solution."
Sie	Wimi teamwork	Not validated	Current web applications are not fitted to strong hierarchical culture.	"We want better user access management features to control what the others see."
Amd	Sending-Blue and TypeForm	No support from the firm	The director had incorrect beliefs about the cause of failure in the reporting process.	"I am the only IT guy for the firm, and I have already too many things to do."
Cis	Advice for strategical changes	Not validated	Projects with strategic goals are too difficult for students to manage.	"I was disappointed by the student's suggestions."

3.4.4. Learnings (think)

Using the results in Table 17, a few main learnings can be identified. First, the failure to find an appropriate solution for the firm Sie may be explained by two reasons. On one hand, the director of the firm disclosed behaviours related to a strict hierarchical culture. Compared to other projects, he was the first interviewee to request a solution with complex features for user access management. On the other hand, the difficulties in defining an appropriate solution were also due to the firm's complex structure. The firm was structured into main departments that collaborated on different projects about the construction of energetic systems. Unfortunately, most of the web applications tested by students fitted the vision that everything should be shared with anyone; this was unacceptable from the director's point of view. Thus, the project was considered a failure because of the too rigid STE's structure and the lack of user restrictions features in the web applications tested by the student.

Second, the director of the firm Amd was interested in the project but he asked the only IT manager of the firm to lead the project. However, this manager already had many other ongoing projects. The risk of minimal participation by STEs cannot be managed by students. A possibility would be to increase the level of participation required to collaborate, such as increasing the number of a firm's participants or interviews. This would naturally select only STEs having strong motivation. However, asking for more involvement from STEs would also reduce the number of potential collaborations. As the overall performance of the other projects was acceptable, the pace of one interview every two weeks with one representative was maintained. Another possibility, which was not feasible in this research, would be to ask a fee for participating, which will also create a filter to select only highly motivated STEs.

Third, the firm Cis asked the student to look for strategies to increase the employees' participation in their internal platform. This objective was perceived as too vague and complex by the student, which led to poor propositions not validated by the firm. To avoid this type of failure, a project's topic should be related to the potential improvement of concrete tasks or processes. However, the fact that other students were able to identify various web applications – such as Kissflow, Wimi, TypeForm, and Event Temple – supports the previous observations about the students' ability to seek and test appropriate solutions by themselves. These solutions were unknown to the students and the STEs before the projects.

Fourth, only two projects led to the adoption of new digital practices. This point illustrates the limits of a small three-month project for successful digital transformation. One explanation comes from the number of collaborators affected by the student's solution. For the two successful projects, the solution adopted only improving the daily tasks of one collaborator. In other words, as the solution would be only used by one collaborator – who was also the interviewee, it was relatively easy for the student to perform a test. The poor results reported for each project in the "Check" boxes of Figure 15 revealed the general inability of students to conduct proper testing sessions. The causes of this inability were mainly a lack of motivation and time among the directors to strongly support any test with their collaborators.

Although seven projects obtained mixed results, the good feedback received from firms Tap, Mbg, and Vic validated the students' ability to trigger changes in the STEs' perception of potential organizational improvements. For instance, the Mbg representative stated, "The tutorial video is great to identify the value of the solution because the student succeeded in performing a demonstration fitted to our daily routines". An anecdote demonstrating a student's value for a firm was that the student Babak obtained a month-long internship at the firm Tap to train a few employees in his solution.

Fifth, another general observation was the general weak motivation among the firms to visit the platform to check the students' models. Only the director of the firm Vic took the necessary time to use the platform and check the student's models. Although the firm Ala claimed that the platform was well made with interesting features, the participants did not really use it during the project because of a lack of time. The same behaviour was observed during other projects.

Furthermore, students did not perceive the PDCA method as an important enabler to conduct the projects or improve the collaboration. Elizam stated that he "would have liked to touch more management tools". It appears that PDCA is a rather general method and lacks specific tools to analyse a firm. The same applies to the usefulness of the absorptive capacity model. Students struggled to properly asses the different contextual factors that could impact the absorption of new knowledge.

Finally, although students worked alone on their projects, they shared their work and ideas. As Elizam explained, "it is mainly to know if we are doing right". In addition, a few companies asked to receive summaries about other projects. Pursuing this idea, the feasibility of sharing the projects' results was evaluated by the STEs' participants. The general feedback was that solutions and models analysing the firm's

situation and processes could be shared if the identity of the firm was not disclosed. Table 18 portrays the learnings from this round with ideas for major changes in the next round.

Table 18: Learnings from the 3rd loop

Learnings	Recommendations
Current low-cost web applications that are easy-to-test and on the Internet do not seem to suit a complex firm's structure.	*It might be interesting to conduct further research on similar projects to confirm this limitation.*
Projects with objectives related to strategic changes are not suited to brief virtual collaboration.	*Projects should focus on process digitalisation, which does not require strong knowledge about strategic changes.*
Projects were well perceived by STEs although they did not adopt the solution.	*The next project plan should focus on increasing the time to raise the participant's awareness instead of trying to test a solution.*
STEs did not use the platform.	*The platform should be seen as a project management tool that helps students to conduct their projects and less as a collaborative tool.*
The dashboard with the PDCA method did not really help students.	*Students still need better management methods to analyse an STE's situation.*
STEs are willing to share their work if the anonymity of firms is guaranteed.	*The platform design should allow knowledge sharing among the projects.*

The learnings from this round revealed that collaboration did not improve with a more structured plan. However, they created enough evidence to pivot the main research objective. I decided to start over with a new platform, with a simplified design, to allow anyone to explore results obtained in other projects. It would also empower students to lead projects by enhancing their analytical skills using methods other than BPMN alone. Therefore, the major change in the research objective was a shift from attempting to improve collaborations between students and STEs to aiming to empower students to help them increase STEs' awareness about the value of new digital practices.

3.5. Second platform (4th loop)

The fourth loop started with the development of a new platform, which was again run on the Firebase system.

3.5.1. Design (act)

The objective of the second platform focused on supporting students in leading their project. In other words, it was not aiming anymore to foster knowledge codification activity for STEs' participants. Three main reasons justified this shift. First, almost every participant from the previous loops failed to properly collaborate on the platform with students. An intermediary conclusion was that participants (almost only directors) are not interested in modelling activities. Second, the willingness of STEs and students to have a convenient solution to look at the other projects involved to completely change the platform design. It resulted in the development of a second platform. Finally, previous students asked a better structuration and documentation about the project plan and a selection of different models to analyse STEs' situation.

The second platform was composed of two tables. One was private, to manage the editing of different models related to a project, and the other was public, disclosing the results of all the projects. Figure 16 summarizes the new platform's design and features. The first table, called "My projects" in the middle screenshot, disclosed the projects assigned to the user. Usually, the student and STE participant saw only one row, corresponding to their mutual project. The next column names "As-Is", "Solutions", "Needs", "To-be", "Context", and "Vision" represented the steps a student had to follow to lead a project.

This new structure standardized the approach of leading a project, but it also offered the possibility to define a specific number of model templates to be filled in for each phase of a project. However, the students were no longer able to create new models and make connections between them. For instance, if a student clicked on a cell under the column "Context", it opened a template of the absorptive capacity model, which the student could merely modify. Users were no longer allowed to create new models in the platform.

The "Vision" column was created to offer an alternative to progress into the project when a student was struggling. Its template gathered different ideas of

business model innovations. It asked students to work on their own vision of what might be disruptive innovations for the STE assigned to them. I assumed that once the student understood the STE's context, he could work by himself on a few ideas for innovations, regardless of the level of participation by the STE. This "Vision" model should reduce the students' frustration to be stuck in case of a non-participation from STEs.

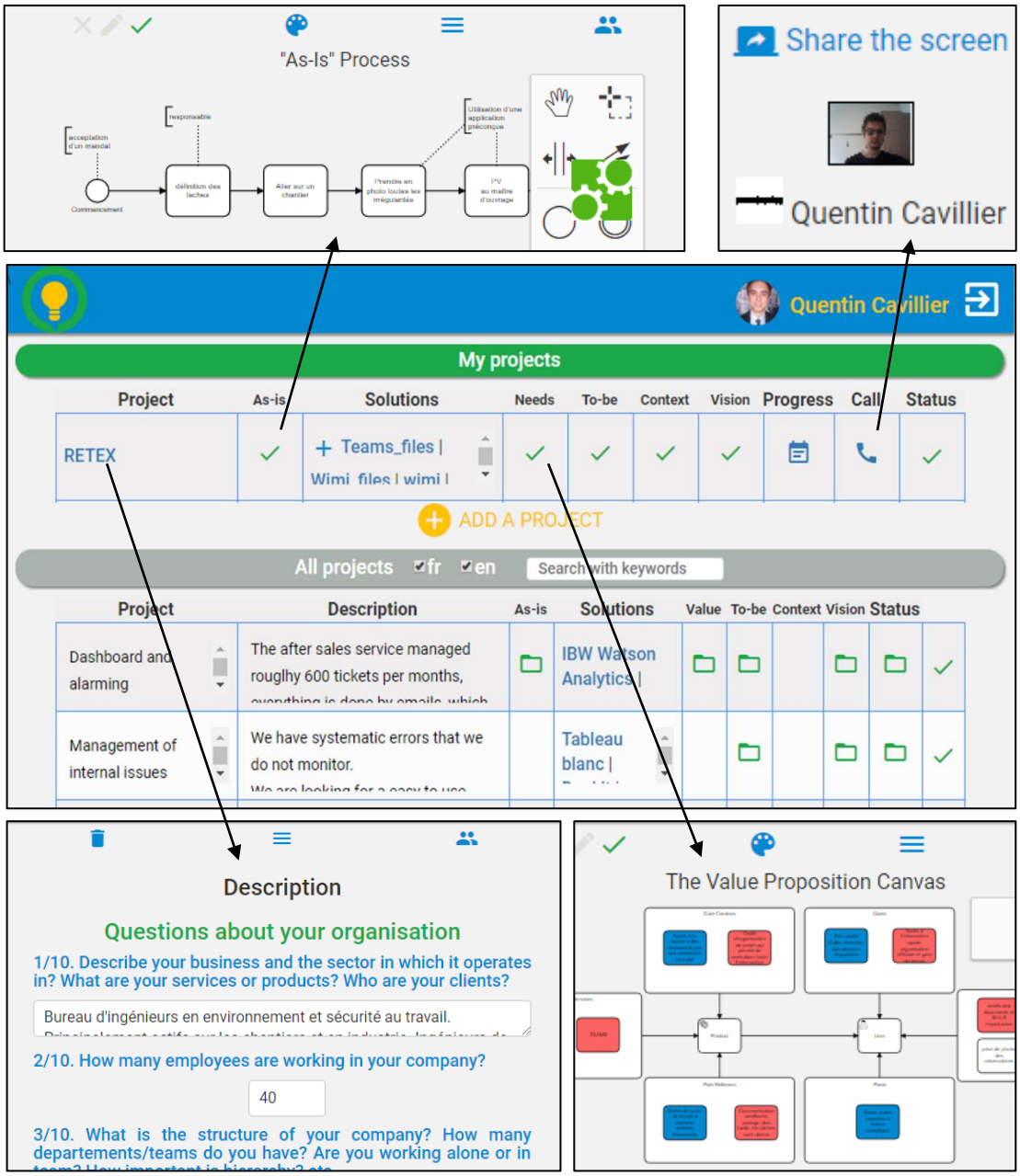


Figure 16: Design of the 2nd platform

Online interviews were planned every two weeks to progress through the five columns of the plan (as-is, solutions, needs, to-be, and context). The "Progress" column opened a webpage where students could create notes about their progress. The purpose was to keep a record of the project's evolution for the research. As in the previous platform, a video-conference application was available under the column "Call".

The second table, called "All projects", was available to everyone visiting the platform. It listed the outcomes of every project with the corresponding links to the models or videos generated by the students. A handbook with complete descriptions about how to apply the models and weekly objectives with questions to ask during interviews were provided to students.

This new project plan followed a different approach from the previous one which used the PDCA method. As previously highlighted, projects failed to complete a full loop of the PDCA method. Projects generally either stagnated at the "Do" or "Check" phases, which produced a strong feeling of frustration for the students. Thus, I chose to change the general approach with a methodology following the idea of the "design thinking" process. This change did not produce many concrete modifications for the project plan. However, its purpose was to change the students' perceptions about the project's objective. Students no longer tried to persuade STE participants to adopt a solution but were focused on obtaining feedback to build a prototype.

This approach was intended to produce less frustration for students because of the lower involvement needed from the STEs for project success. The design thinking process is composed of five main phases, called "Empathize", "Define", "Ideate", "Prototype", and "Test".

The column "Project" was helpful for the student to start the "Empathize" phase. For instance, clicking on the name "Retex" in Figure 16 would open a description submitted by the STE to introduce the firm's situation to the student. A 10-question survey had to be filled by the participant to describe their needs and the context. After assigning a student to the project, a first interview was planned to help the student complete the first phase.

The "As-is" model supported the student in the "Define" phase. The student had to perform a BPM to make a model of the non-optimized process, called "As-is". It asked the participant to validate the model to develop a shared vision with the student about the issues related to the non-optimized process.

For the "Ideate" phase, the student had to post three videos introducing different web applications under the column "Solutions". Constraints related to the video design were slightly different compared with the previous loop. The video should also be available on the public platform and thus was not allowed to disclose any information that could identify the STE. The STE participant was required to watch the three videos of solutions carefully and select the one that seemed most valuable.

The "Prototype" phase was realized with the help of the columns "Needs" and "To-be". The model "Needs" used the value proposition canvas to help the student and the participant to clearly establish the benefits of the chosen solution. The use of this canvas aimed to reduce the misunderstandings between the student and the participant about the key features needed; this was expected to help in the final design of a prototype. The model "To-be" was a BPM representing a prototype of an optimized process using the solution. Once again, the participant had to validate the models done by the student to move to the next phase. This step also provided security in obtaining the approval of the participant to publicly disclose the models.

The last phase, "Test", was probably the most difficult for students to perform because of the risk of weak involvement from STEs. I decided to continue using the absorptive capacity model to help students review the potential barriers to the adoption of their optimized process. Using this approach provided certain flexibility for either performing a real test if the STE was strongly involved or simply filling in the model based on the student's understanding. This flexibility aimed to reduce students' frustrations if STEs lacked the resources or motivation for the testing phase.

I also decided to remove the criteria of the technology acceptance model for the "Test" phase because of its poor added-value for the project. Through the few cases that applied this model during the previous loop, I noted that criteria such as usefulness or "easy-to-use" were always positives without further details. This tendency to produce only positive feedback was logical; usually, a solution is chosen for its usefulness and its easy-to-use design. Therefore, using this model in this research context did not add valuable data. The following questions summarized the main objectives of this round:

- **Do students show better performance with access to other projects' results?**
- **Does the new platform design empower students to lead projects?**

Finally, data from previous projects were modified and integrated into the new platform. This was done to provide examples to students and STEs visiting the platform.

3.5.2. Settings

The recruiting process of this round was similar to the previous one. An email introducing the research and presenting the platform was sent to STEs. However, the email presented the concept of sharing each project's data through an Internet link to the public aspect of the platform. It also introduced the 10-question survey to submit a project. A total of 11 STEs submitted a project on the platform. After a first interview, seven STEs were selected for the research. Only four students registered for a semester project. Table 19 describes the different projects, firms, and students' assignments.

Table 19: Project descriptions of the 4th loop

N°	Name	Sector	Size	Projects topics	Students
15	Stg	Textile Machine	50	Client follow-up	Corentin
16	Pro	Training agency	25	Students follow-up	Corentin
17	Bol	Construction	30	Knowledge management	David
18	Bak	Construction	60	Task management	David
19	Eco	Civil engineering	25	Knowledge management	Romain
20	Pet	Civil engineering	20	Issue management	Julien
21	Pla	Civil engineering	80	Project management	Romain, Julien

3.5.3. Overview (look)

The results of the fourth loop were disappointing, mainly because of general weak involvement by STEs participants. Over the seven projects, only three firms recognized the value of the solutions proposed by students. Another reason was a change of mind among the participants about the necessity to look for solutions developed by a consultancy firm, after having seen the students' propositions. Another reason was the low motivation of two students to lead their projects. A lack of

proactiveness and involvement in defining the needs of participants and seeking appropriate solutions were observed. Table 20 shows more details about the behaviours observed in the seven projects.

Table 20: Results of the 4th loop

Name	Solution	Result	Observation	Quote
Pro	Airtable	Validated but not tested	The director gave up the test because of a lack of motivation from his collaborators.	"I was amazed by how quickly Corentin grasped our situation."
Eco	Microsoft Teams	Validated but not tested	The project stagnated in the validating phase.	"We need more time to make a decision with the other directors."
Pet	Typeform	Tested but not adopted	A lack of support from the manager to try the solution.	"The project is too short, which makes the end abrupt."
Stg	Airtable	Not validated	The manager decided to look for customization of the current solution with a consultancy firm.	"After a discussion with the director, we will continue using our professional solutions."
Bol	Dropbox	Not validated	The student did not understand the need of the director.	"I was expecting something more global, [...] but we remained focused on document management."
Bak	Airtable	Not validated	The manager decided to look for a solution provided by a consultancy firm.	"The conclusions of the students are interesting for developing new services."
Pla	Wimi	Not validated	Even if the director was not sufficiently involved, the students also lacked proactiveness.	"I had only very little time for the project." "Students could have sought a little more."

3.5.4. Learnings (think)

Knowing that misfortune is sometimes an opportunity in disguise, I sought further evidence from this round. However, we should be really cautious about them because of the general change in the behaviour of the participants in this round. An advantage of having people with low motivation leading a project was that these highlighted which tasks were perceived as a waste of time. These tasks were not perceived as annoying in the previous round because of the higher general motivation among participants.

First, although the students found it easy to use the platform and followed the project plan, David highlighted the need for a document that would explain in detail the tasks to perform, with better definitions of the various parts of the models. For instance, the template for the value proposition canvas was not clear enough by itself, which produced incorrect data. The same observation was made for the attempt to apply the absorptive capacity model to the different firms' contexts.

Second, students pointed out the task of making three videos as inefficient because of the amount of time needed to produce the videos and the few minutes accorded by the directors to watch them. Another method would be to let students perform live demonstrations of the solution. This would also allow the participant to highlight specific needs that had been forgotten in the planning phase. Furthermore, students usually took a full interview to answer directors' question about the solution chosen from the videos. Thus, it seemed more efficient to directly provide live demonstrations.

Third, the firms Stg and Bak quickly lost their involvement in the project because they realised that they wanted to continue using their current solution by asking a consultancy firm to make customizations. This behaviour had already been observed with the firm Ala during the previous loop. These cases revealed that firms with solutions already deeply implemented in the business processes had a low chance of being interested in a solution proposed by a student.

Fourth, the risk of recruiting students with weak motivation cannot be well managed. The constraints related to the research design only allowed one interview with a student to assess their motivation before starting the project. Furthermore, most students were generally motivated at the beginning of the project; the difference emerged in their resilience to continue the project once they faced barriers or deception. Propositions by students to avoid these situations included working in

teams on projects and selecting only firms that could allocate enough time for a project.

Finally, students were asked to report on the project's evolution under the "progress" column. However, most students failed to write weekly reports on the platform. Two reasons explain this behaviour. On the one hand, the students perceived this task as annoying and unimportant for their project. On the other hand, I did not check enough on their progress and forgot to send reminders. Therefore, it would be interesting to add the student's ability to do proper weekly reporting as part of the grading for the project. Increasing the monitoring of projects might also help to prevent a loss of motivation when students face difficulties. Table 21 sums up the main learnings from this round and the actions to take for the next loop.

Table 21: Learnings from the 4th loop

Learnings	Recommendations
Difficulties in applying the templates of the models.	*Either redesign the models or provide better documentation about them.*
Making three videos to introduce the solutions is inefficient.	*Propose live demonstrations of three solutions.*
STEs with systems already deeply implemented in their processes are not suited for these projects.	*Asking about the systems already used in the company before starting the project.*
Students can lose their motivation quickly when they face difficulties.	*A better monitoring system and approach might help to prevent a loss of motivation.*

The difficulties encountered during this loop did not allow for strong conclusions about the impact of the new platform design on project efficiency. It appears that students found the platform easy to use, but they had difficulties matching the STEs' requests with the project plan. Furthermore, they did not really look at each other's projects. Therefore, another loop to test the new platform seems necessary before attempting to answer the two questions for this loop.

3.6. Second platform (5th loop)

The fifth loop was focused on improving the methodology to support and monitor a student over the different phases of a project.

3.6.1. Design (act)

A first improvement made for the fifth loop was a rearrangement of the platform design and project plan. Figure 17 shows the new project plan composed of the columns Project, As-Is, Selection, To-Be, Video, Culture, Conclusion, and Annex. The "Empathize" and "Define" phases were similar to the previous loop. Nevertheless, detailed documentation about weekly objectives (questions to ask, factors to assess, etc…) was provided to help students manage their project (see Appendix 2).

Considering the students' observations about the uselessness of making three videos to introduce the solutions, I decided to ask students to present their solutions with live demonstrations in the "Ideate" phase. Thus, using the "Selection" model (called "Needs" in the previous loop), students highlighted the benefits of the solution chosen using the value proposition canvas. However, using feedback from previous students, a redesigned template for the value proposition canvas was presented in the form of process (see the upper part of Figure 17). This replaced the boxes in the original version (see Figure 10, p.72). The new template clarified the methodology to follow to link the solutions' values to the tasks to be optimized.

The "prototype phase" remained almost identical to the design of the "to-be" process. However, students had to produce one video to describe their prototype. The desire to maintain the production of one video per project had two reasons: 1) the need for a simple way to share projects results on the platform, and 2) the attempt to use the video to assess employees' reactions. In previous loops, I had attempted to persuade the students to conduct real tests with participants. For this loop, students had to assess their prototypes through feedback from various people by sending the video link to colleagues of the participants. This shift followed the new purpose of the platform, namely, to increase the awareness of STEs instead of trying to implement transformations.

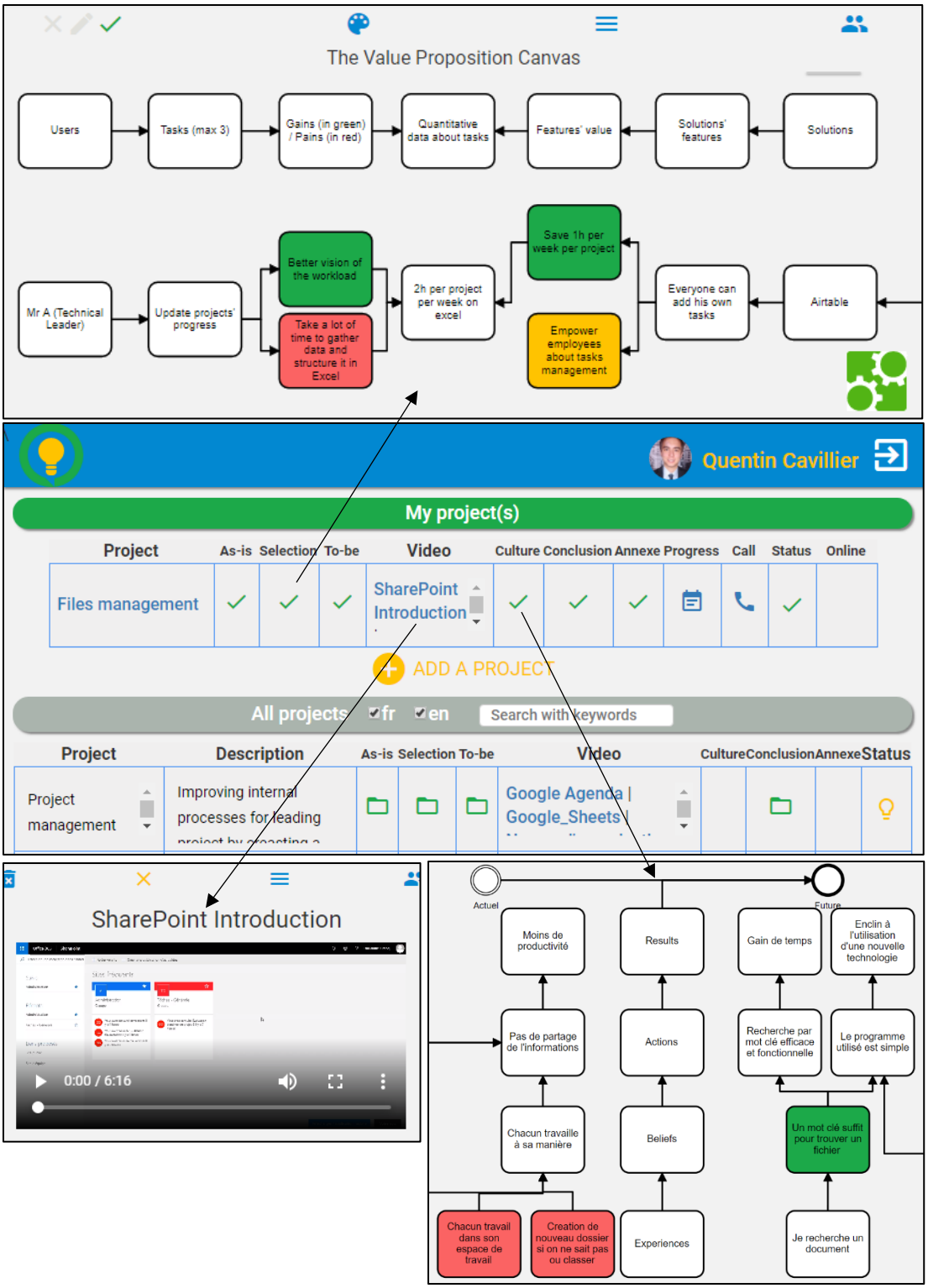


Figure 17: Screenshots of the improved version of the 2nd platform

Finally, the "Test" phase tested the reactions of colleagues of the STE participant to the solution. Analysing these reactions helped students to highlight the organizational culture through the use of a new framework, called the Result Pyramid (see the bottom part of Figure 17). I had discovered this framework during the previous semester at a conference. As students were still struggling to use the absorptive capacity framework, I decided to use this new one to train them in the analysis of organizational culture. I expected that the results would help students to develop better outcomes with the absorptive capacity framework afterwards.

A second improvement was the monitoring system. Figure 18 shows a view of the webpage "Progress", which presented a list of 12 points for students to follow to upload their weekly progress. At the beginning of the project, they received a template document with a description of the tasks to perform each week. They had to complete this document every week. For instance, the objectives of the third week were to integrate a screenshot of the model "As-Is", and to describe a few observations from the interview – such as difficulties encountered, the participant's reaction, and the perceived usefulness of the modelling activities.

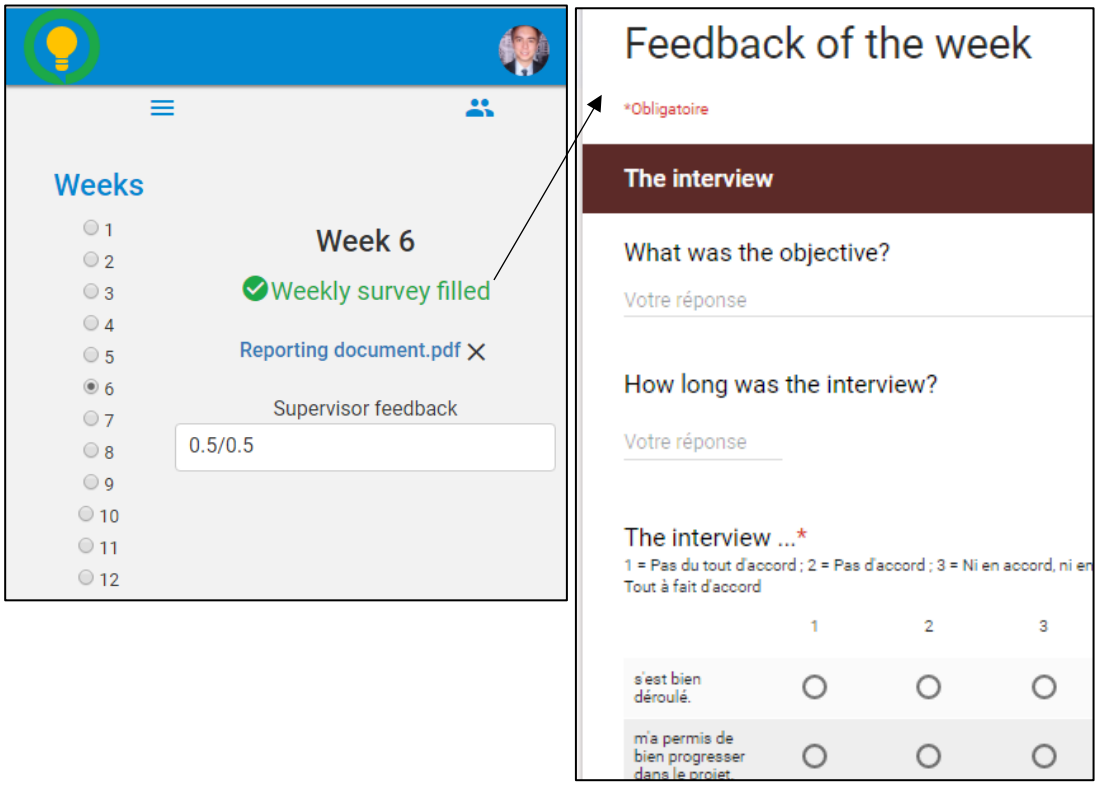


Figure 18: Screenshots of the "Progress" webpage and the weekly survey monitoring the student progress

Furthermore, the students had to fill in a form every week, composed of items assessing their feelings for the week using a Likert scale (5-point scale). After each interview, they also had to report five quotes from the participants (see Appendix 3).

3.6.2. Settings

The STEs and student recruitments in this loop proceeded in the same way as the last loop. However, the number of answers reached a better score than all the previous loops. 13 STEs were interested in participating, and 10 accepted the conditions of participation – such as performing one interview per week. Table 22 lists the different projects with their respective firms. Nine students asked to participate, with only two for 10-credit projects. The seven students who applied for 4-credit projects had one project to manage; the two other students received two projects to manage. Only one project by Guillaume was disclosed because his second project was done for a large company where he held a part-time job.

Table 22: Project descriptions of the 5th loop

N°	Name	Sector	Size	Project topics	Students
22	Pro	Dealership	30	After-sales process	Guillaume
23	Bio	Food production	40	Resource management	Sofia
24	Dia	Security service	40	Selling process	Chloe
25	Aev	Medical group	300	Platform employee	Romain
26	Arr	Architect office	40	Benefits of BIM	Mathieu
27	Cit	Urban office	60	Knowledge management	Lucas
28	Ste	Construction	20	Inventory management	Younes
29	Noe	Event organizer	40	Inventory management	Martin
30	Pol	Public services	170	Employees platform	Marc
31	Gdc	Energy services	60	After-sales process	Marc

Based on observations from the previous loops, I understood that only certain types of projects had a reasonable chance of success. Thus, it is important to discuss the objectives of the projects for the firms Aev, Arr, Pol, and Gdc, which did not fit the standard approach of seeking a solution to optimize a process. The firms Aev and Pol sought to improve and redesign their internal platforms to enhance the employees' participation. Although they wanted a new solution for their platforms, these two projects were more complex than optimizing a specific task of a process. However, I included this project to assess the students' capabilities to handle complex projects.

The projects for the firms Arr and Gdc also had a particularity. They were at the beginning of a digital transformation. In other words, they had already chosen a solution, but they were interested in obtaining support to explore those solutions.

3.6.3. Overview (look)

Project results for this loop were varied. At one extreme, a firm fully adopted the solution; at the other, the firm described the student's work as insufficient.

Table 23 classifies the projects according to the different results, from success to failure.

Table 23: Results of the 5th loop

Name	Solution	Result	Observation	Quote
Pro	SharePoint	Adopted	The director was closely involved in the project.	"The student's work went beyond my expectations."
Cit	Google Maps	Tested and close to being adopted	The collaboration went well because the student collaborated with two young engineers.	"The student did good work, but we are sceptical that our people will be willing to change."
Ste	Airtable	Adopted	The manager and director were both highly motivated, which helped the student to overcome his natural shyness.	"The student was a bit shy at the beginning but did a good job."

Bio	Calamri	Validated but not tested	The director himself found another solution.	"Even though I did not retain the student's solution, it was a nice experience."
Dia	Airtable	Validated but not tested	Interviews with the director were difficult but the student was able to gain contact with other collaborators.	From a collaborator: "It is sad that I did not meet [the student] before because her solution seems super interesting."
Aev	Absence.io	Validated but not tested	The student struggled to define project requirements.	"The platform is nice, but it cannot be integrated with our current system."
Noe	LogPos	Tested but not adopted	The manager who collaborated with the student stopped the project after receiving feedback from the director, for unknown reasons.	"The solution is good, but our director does not want to adopt it for the moment."
Arr	Methodology to use BIM	Not validated	The student liked the project, but it was not perceived as useful by the firm.	"Until we have the templates for BIM, we will not move forward in the process."
Pol	Did not find any solution	Not validated	The student was not motivated, which was seen in his incapacity to provide weekly reports	"The student's work was insufficient, and no valuable ideas have been discussed."
Gdc	Propositions of tutorials	Not validated	Although the student failed to properly lead the project, the firm was also absent.	"We did not really interact with the student."

Three projects were successful, with the firms demonstrating positive behaviours to adopt the students' solutions. Four projects did not reach the last phase of the plan. However, as positive feedback was obtained from the students and firms for these projects, they were classified as moderate successes (highlighted in yellow in Table 23). The three projects highlighted in red failed for reasons already encountered in previous loops, such as a lack of involvement from the student and the STEs, or project requirements that were too vague or too complex.

A general observation was the difficulty of maintaining the pace of one interview per week for almost all the projects. The project plan expected eight interviews over two months, with a third month as a buffer in case an interview needed to be moved. However, only the collaborations with firms Ste, Bio, Cit, and Pro produced at least six interviews over the three months.

3.6.4. Learnings (think)

The students who were motivated by their projects shared different feedback about the value perceived regarding the models and frameworks applied during the project. For instance, Sofia pointed out the usefulness of the value proposition canvas in reminding her of the key criteria for firms. She explained that "without the model, it would have been difficult for me to keep in mind the important things about the project as I have many other courses and projects in parallel." The new design of the canvas seemed to be easier to follow than the original one.

The frameworks using the Result Pyramid and the absorptive capacity model received mixed feedback. Lucas shared his impression that he was making hypotheses about the firm's behaviours because he was an outsider who did not know enough about the daily experiences faced by the collaborators. Although Lucas's feedback summed up the general perception of the students, Guillaume found it interesting to learn about this framework as a tool to analyse a firm's culture. Similar feelings were reported about the use of the absorptive capacity model for the project's conclusion.

The new approach of sharing one video of a solution with a few other collaborators of an STE produced better results than the attempts to conduct small tests. For instance, it allowed Chloe to meet a collaborator whose motivation about her solution was stronger than that of the director involved in the project.

The students who collaborated with motivated STEs on a project with clear objectives showed a great level of empowerment. For instance, I did not need to

supervise Guillaume, Lucas, Martin because they showed a great level of self-government. Usually, I met them only to collect their feedback about the projects. By contrast, the projects attributed to Romain and Mathieu had a more complex topic such as designing a platform for employees and defining the benefits of a new method called Building Information Management (BIM). I had to spend much time with them trying to maintain their motivation to continue the project.

The observations from this loop supported the choice of a platform design with a well-defined structure and a standard plan. However, the disadvantage of having a rigid project plan with detailed weekly objectives was the need to reassure some students when they faced unplanned changes. This behaviour supported the previous observations about a lack of proactiveness among students when they were unable to follow a plan. Table 24 sums up the main findings from the fifth loop.

Table 24: Learnings from the 5th loop

Learnings	Recommendations
The weekly document to fill in was too time-consuming	*Removal of the document and only using the survey to monitor the student.*
Overall incapacity of STEs to ensure one interview per week The models were well perceived by students. The rigidity of the plan produced stress for students when they were unable to follow the objectives. However, they were generally able to manage a project without my intervention.	*We cannot really improve the platform based on the three last learnings with the actual research design. Thus, a final loop to validate the learnings is planned, and suggestions for alternative research designs will be proposed.*

Overall, this loop seemed to yield better feedback from students than did previous loops. Even students who struggled to collaborate with non-involved STEs were less disappointed because they were still able to move through almost all the phases of their projects.

3.7. Second platform (6th loop)

As highlighted in the learnings of the previous loop, the research has reached its maturity threshold about the potential improvements that could be made without doing major changes into the research context. For instance, Guillaume proposed to ask a fee to STEs that could be refunded if they were able to ensure one interview per week during the project. Even though this idea has potential, it would be a major change to the research context. Thus, the aim of this last loop was not to explore the test new actions but to increase the validity of the new platform design value. Only a few small adjustments were performed.

3.7.1. Design (act)

The monitoring method was modified by removing the document to complete each week. Based on the feedback from students of the previous loop, this document was time-consuming. Furthermore, I noticed that the weekly survey was providing enough data about the interviews made by students and their current feelings. The survey to fill in after each interview was maintained to gather data about the interviews and the students' feelings.

3.7.2. Settings

The same approach as in the two previous loops was applied to contact STEs and students for this loop. In addition, a proposal to conduct a second project was sent to the firms Arr and Vic because they had requested a second project at the end of their first. A total of eight projects were selected and 11 students were recruited. Five students were applying for 4-credit projects and this group was split into two teams. The other students worked alone to validate their 10-credit projects. Table 25 shows the project descriptions.

Table 25: Project descriptions of the 6th loop

N°	Name	Sector	Size	Project topics	Students
32	Fac	Construction	35	Global improvement	Ju, Mo, Ya
33	Dar	Logistic	25	Purchasing	Victor
34	Eve	Event services	11	Inventory management	Sinan
35	Fli	Manufacturing	300	CRM	Othman
36	Arr	Architectural	40	Research on ArchiCad	Karim, Charles
37	Kar	Industry	13	New ERP	Emmanuelle
38	Emm	Industry	300	R&D management	Marcel
39	Vic	HR Consulting	50	Reporting Improvement	Alexis

3.7.3. Overview (look)

As with the previous loops, a summary of the projects' results is presented (see Table 26). An important difference compared to previous loops was the weak support I provided to students. I wanted to assess their ability to follow a project plan without group meetings to explain the models or methods to them.

For this last loop, half of the students succeeded in leading their project autonomously. Only the project Fli did not produce concrete results. The projects Kar, Arr, and Dar stagnated in the prototype phase because of external factors, such as lack of involvement from the STE participants or too ambitious an objective for the project.

The failure of the project Fli was due to a different reason. Fli was one of the biggest firms that participated in this research. The participant, who was the CTO, expected Othman (the student) to interview various salesmen to define the requirements for CRM. However, the CTO failed to properly inform the salesmen about the project, which wasted time during the interviews as Othman had to explain the project and its objective. Then, the CTO was interested in professional solutions that the student could not easily access or test. Furthermore, Othman was not strongly motivated from the beginning. Thus, he did not strive to overcome the obstacles and waited until the end of the project to complain about the project and the CTO's attitude.

Table 26: Results of the 6th loop

Name	Solution	Result	Observation	Quote
Fac	Google Agenda and Sheets	Adopted	Students only proposed basic solutions, but the director was satisfied.	“We watched tutorials to become more efficient with this software”.
Emm	Airtable	Adopted	The project sped up because the student was able to present the solution to a team.	“Your proposition is really matching our needs”
Vic	PowerBI	Adopted	Top management was closely involved.	“This solution is miraculous; I am sure it will work…”
Eve	Current RMS	Tested but not adopted	The student did amazing work by contacting many solutions providers	“There are aspects that I hadn't thought of that are present in Current RMS.”
Dar	Macro Excel	Good start but not enough developed	Only a few exchanges during the project.	“To use the macro, I would need more time with the student.”
Kar	Odoo	Validated but not tested	The students struggled to schedule interviews with the director	“Our consultant was reticent about Odoo, but the discussion has changed.”
Arr	ArchiCad	Struggled to improve ArchiCad usage	Students felt useless because they had no previous experience in ArchiCad.	“We would like a template that our architects could use as a starting point for practising BIM.”
Fli	Freshsales	Stagnated in the project’s requirements	The student was intimidated by the manager.	“We wanted a strong comparison of solutions and not a unique proposition.”

The project Arr failed because of a too-ambitious objective. The managers wanted the two students, Karim and Charles, to learn to use the solution ArchiCad to look for best practices that might reduce repetitive tasks for the collaborators. However, the students reported some feelings about the uselessness of the project.

They were rather disappointed because they spent more time asking questions about ArchiCad than proposing improvements.

The projects Fac, Eve, Vic achieved full success because of strong involvement from the students and participants – who were STE directors. For the firms Eve and Vic, new directors had recently been hired, which brought a new vision to the company and strong support for change. Combined with this favourable situation, the students in these two projects were strongly motivated, which produced positive results. As an anecdote, the director of Vic invited Adrien to the firm's Christmas dinner as a gesture of appreciation for his good work. For Fac, the three students (Ju, Mo, Ya) did not show strong motivation during the project. However, they devised "quick wins" for the firm, which was enough for the director. The director even asked students to conduct an on-site training session for the employees.

An interesting final observation was the reason for the success of the project Emm. Marcel had a difficult time to define a few solutions that the R&D manager accepted. However, he had the opportunity to present them to the R&D engineers before final validation from the manager. After the presentation, the engineers showed a strong interest in one solution, which motivated the manager to validate that solution and move to the testing phase.

3.7.4. Learnings (think)

From an overall perspective, the last loop was the most successful of this study because of its 50% rate of successful projects. Furthermore, the fact that students were able to lead their projects without the need for strong support from the supervisor (me) demonstrated the value of the platform. The structure of the platform seemed efficient to provide enough information to create the right knowledge for students to lead the projects. Furthermore, results from this last loop confirmed the learnings from previous loops.

The failure of the project Fli highlighted the need to restrict projects to small firms that sought solutions that would be accessible to students. Large firms tended to expect students to perform a thorough analysis of the situation through numerous interviews with different participants, which is too time-consuming for a small project. Moreover, project requirements at medium or large firms were usually perceived as too complex by students, which reduced their motivation.

The mixed results for the projects Arr and Dar supported previous learnings about the risk facing students who were expected to improve or customize a current solution. These types of projects required students to develop strong skills about the current solution, which was difficult in just three months and with limited access to the firm's resources. However, the participants gave good feedback about the collaboration as it had allowed them to rethink their way of working; this should motivate further research to keep such projects within the research scope. Students should simply be aware of the difficulty of such projects before starting them.

The success of the projects Fac, Eve, and Vic was either the consequence of strong support from top management and close involvement from the student or the consequence of a project with objectives that were easily attainable by students. These two observations illustrate the importance of top-management support and defining a project's requirements to suit a student's abilities. The success of the project Emm highlights an important learning about the value of holding group meetings with other collaborators of STEs early in a project. Therefore, students should perform live demonstrations for teams of STE collaborators instead of directors only.

Table 27: Learnings from the 6th loop

Learnings
Top management support is the key factor for the success of the projects.
Strong motivation from students is not essential if the project's requirements are well defined and not too complex.
Medium and large firms are not suited to these types of small projects.
Projects about optimizing current solutions should be managed very cautiously.
The use of the platform empowered the students. The supervisor did not need to allocate the same amount of time to support the students as for the projects on the first platform.

3.8. Discussion

Bhatt (2001) suggested that knowledge management research should conjointly analyse the technological and social systems, in other words, the interactions between people, techniques, and technologies. He defines knowledge management systems as systems composed of five activities: knowledge creation, knowledge validation, knowledge presentation, knowledge distribution, and knowledge application. The following discussion uses these five lenses to analyse the platforms' performance. For each activity, a comparison between the two platforms' designs emphases the challenges and strategies tested. Additionally, short discussions about the reasons for projects' failures produce insights about the real students' value.

3.8.1. Knowledge creation and validation

The knowledge creation and validation activities were performed by students and STEs while they went through the "Empathize" and "Define" phases of the Design Thinking process, which corresponded to the "As-is" and "Selection" steps of a project.

Amabile (1983) defines domain-relevant skills, creativity-relevant skills, and task motivation as a set of sufficient and necessary components to be efficient in a creative process. According to Zhang and Bartol (2010), intrinsic motivation strongly moderates the engagement of people in a creative process. Thus, the intrinsic motivation of the students is analysed through the evolution of three psychological needs: competence, autonomy, and relatedness (Ryan and Deci 2000).

For the creation and validation activities, 13 collaborations over the 39 projects failed to create and validate knowledge about potential digital transformation for the STEs involved (see projects highlighted in red in tables of each loop). The complexity of the project objectives was one cause for these failures. Most of the projects focused on optimizing a specific task in a daily routine; however, the five companies Aev, Arr, Cis, Pol, and Sie proposed more complex topics such as designing an employees' platform or defining a new management strategy. Students involved in these projects argued that they did not have adequate competences and resources, resulting in a loss of motivation and stagnation in the creation phase. Furthermore, a weak involvement from the companies Amd, Bak, Pla, and Stg was a second cause of failure in the creation phase. This lack of involvement created a gap that hindered the student to

develop the appropriate level of relatedness to maintain the necessary motivation to continue the project.

Despite these 13 companies, the interactions among people, techniques, and technologies during the “empathize” and “validation” phases were strong enough to create and validate new knowledge. This has been measured through the acknowledgement of the 25 other STEs about the value of the solutions proposed by students.

Only three students of the 33 had difficulties finding and learning Internet solutions. During this first activity, the observations about students’ behaviours – such as proactiveness, ability to propose innovative solutions, feelings of deception when STEs were not participating – highlighted a general strong intrinsic motivation to participate into the projects. The general students’ opinion after this first activity is well summarized by a student’s quote, “We liked this kind of project because we are working on something that might really be useful for improving someone’s life.”

Another finding was that even though students showed difficulties grasping the STEs’ contexts because of the long-distant interviews, most of them were still able to come up with solutions validated by the STEs. Only five projects were blocked during the validation phase because students were not able to find solutions matching the participants’ needs. For three projects, the students simply did not find a solution even though they had a strong motivation to seek and test many solutions. For the two others, unfortunately, the students showed a low motivation from the beginning, which yielded solutions not corresponding to the requirements.

From a technological perspective, STEs showed a lack of skills to set up video conference calls. An alternative to reduce the technological issue to do the interviews through phone calls using a screen sharing application where STEs had only to click on an Internet link to see the students’ screens.

From a technical perspective, STEs had interviews planned every two weeks with personal objectives to do for the other weeks. However, STEs were rarely doing their personal objectives by themselves such as improving and validating the business process. Thus, the new methodology for the second platform was to make interviews of 30 minutes every week and remove the STEs’ personal objectives. The pace of one short interview every week was not perceived as a barrier to participating for STEs. After two or three online workshops, students were able to produce a BPM to represent the STEs’ current process for pointing out potential tasks to improve. Surprisingly, most of the STEs did not perceive the value of participating in BPM even though they

understood it was essential for the student. Thus, STEs demonstrated a lack of interest in developing a comprehensive view of their business processes with a mindset focused on immediate results. and to perform BPM by themselves. Finally, live demonstrations were sufficient for STEs to validate a solution. These improved interactions and helped students to continuously increase their understanding of the issue. Included the Value Propositions Canvas in the second platform was positive as one student explained, “It was easy to apply for making the links between what the solution can do and what it cannot do. Therefore, it really helped me to remember during the project what was the real goals of the project.”

3.8.2. Knowledge presentation and distribution

The presentation and distribution of new knowledge may be associated with the “ideate” and “prototype” phases, which are corresponding to the “to-be” and “video” columns on the platform. Doing the sum of the projects highlighted in yellow in each table of each loop, 16 collaborations stopped either in the presentation or distribution of the new knowledge produced. Feedback from the 16 STEs is pointing out three reasons about these stagnations.

First, the most negative impact on the 16 collaborations was the lack of relatedness often felt by students while they were asking STEs participants to perform tasks such as validating a prototype or distribute a tutorial to a team of testers. Eight companies over the 16 argued a lack of time or resources to justify their incapacity to properly support the student. Even though these STEs agreed on the value of adopting the students’ solutions, the pressure to achieve their daily work was too much to take the appropriate time to test the solutions. Each time, the intrinsic motivation from students dropped once they had to start sending remainder e-mails asking STEs to participate. While a team was needed to test a solution, the main participant of the STE was not supporting enough the student in motivating the team to be involved. Therefore, three projects started a real test but failed because of this reason. However, the project was still considered by STEs’ participants as a valuable experience as demonstrated to the claim made by a participant: “Even if we did not find the time to support the test of the solution, we were satisfied because the project showed us the crux of the problem.”

As a side note, this participant offered a two-week internship to the student after the project completion and, six months later, he was motivated to propose a

second project for another student. Interestingly, a few interviews have been performed among the 16 STEs that stagnated in the knowledge presentation and distribution phases one year after their participation. General feedback was that they were continuing to explore solutions by themselves based on previous students' work.

Second, five STEs decided to stop the project because they figured out new requirements such as the need to integrate the solution to another system or to find an IT partner/consultant to support them. Finally, the three last STEs argued that the resistance from their employees or from another director was too high to test the solution.

A comparison of the two platforms highlights the limitations of these distant collaborative projects to work on presentation and distribution of new knowledge. For the first platform, the assumption was that STEs would actively participate in working on the "To-be" model and the realization and distribution of tutorials. The objective was to offer a small private knowledge management system where students and STEs could easily develop custom tutorials for each process that STEs should reuse to spread and apply new digital practices. It would require from STEs' participants to motivate their colleagues to create an account on the platform and look at the different models and tutorials. However, STEs were not interested in dedicating enough resources to analyse their working processes, create tutorials, and push colleagues to look at them. They were only interested in improving their understanding of the potential of this new ecosystem of web applications.

With the second platform, students were to follow a rigid plan. Outcomes of every step were publicly shared on the platform to increase the students' confidence about the correctness of their work. Even when collaboration with the main STEs' participant was lacking, students could progress on presenting and distributing a video introducing their solutions to other STEs' collaborators. Instead of asking collaborators to register on the platform, students could send an email with the public link of the video. Then, they were either asking collaborators feedback by phone calls or emails. Secondly, STEs felt satisfied because they received a more structured report analysing their situation. Finally, as models and videos were public on the platform, this increased the motivation of other STEs to participate. A few STEs declared that they had looked at other projects either to seek solutions for other issues or to have a better idea of the kinds of projects students were doing.

Therefore, a major finding of the research is the STEs' readiness to allow students to publicly display the project results on the platform. Indeed, the first

assumption that led to the design of private workspace on the first platform was incorrect. STEs do not really care about sharing information on their business process if their identity is hidden. From an academic and education point of view, being able to reuse and share these results offers a new field for knowledge management experiments.

3.8.3. Knowledge application

The application of new knowledge was complex to assess as it would require longitudinal data about STEs using the students' solutions. However, we highlighted 10 projects that ended with either a beginning of adoption by STEs or a strong willingness to start using the solution. that four of the 10 successful projects were impacting only one or two people.

Finally, feedback from participants revealed that most of the STEs are feeling comfortable while working with students, which may not always be the cases when you are working with consultants or experts. Even though 75% of the projects failed to adopt a new solution, several STEs claimed that just taking the time with a student to think about how to optimize their daily routines was valuable enough.

3.8.4. Overview

Figure 19 sums up the results of the success rate through the five different knowledge activities over the twenty-nine projects led on the two platforms. The fact that 67 (41+26) per cent of the solutions proposed by students were validated by companies proves the students' ability to create valuable knowledge for small firms. However, 41 per cent of the projects failed in the presentation and distribution of new knowledge, mainly because of a lack of motivation, leadership, time, and resources from STEs and a lack of confidence from students to push STEs to test their solution. For instance, even though project's guidelines were to send a reminder in the same week if STEs were not taken any action to test the solution, students were usually waiting two-three weeks before daring to send a reminder.

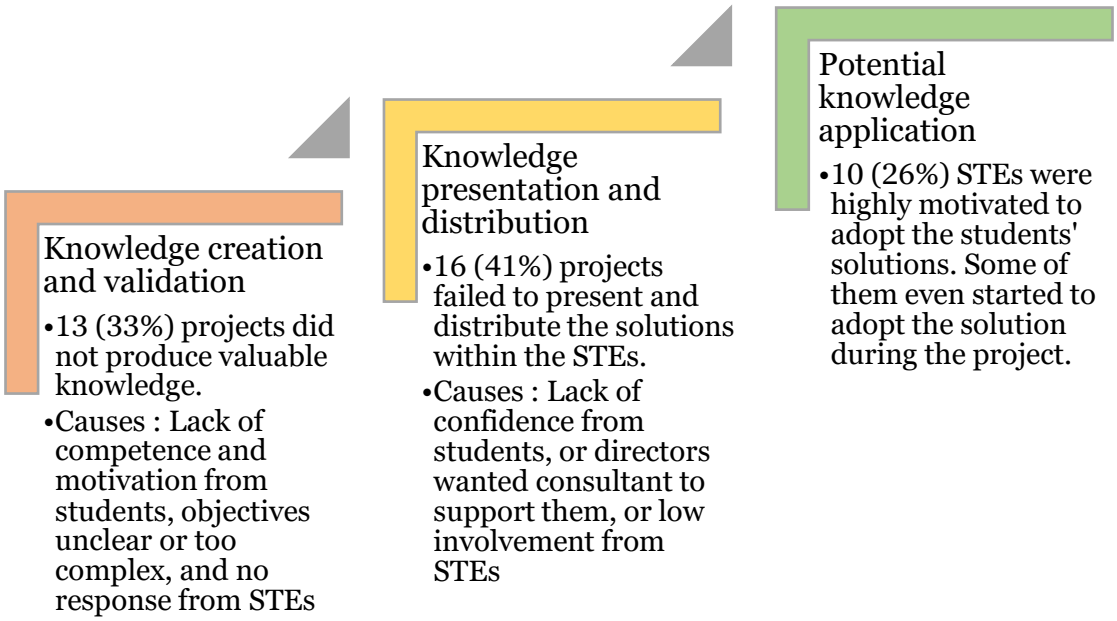


Figure 19: Success rates of the different projects' phases

A main difference between the first and second platform lies in the definition of projects' purpose. The first platform was designed to analyse the business processes and develop the analytical skills of students and STEs. The first belief was also that students and STEs would be able to quickly test cloud solutions. Therefore, for the students involved in the test of the first platform, strong feelings of deception toward STEs were observed when they were failing in the presentation, distribution, or application of new knowledge. However, for students involved in the second platform test, such feelings were weaker as it was clearly explained at the beginning of the projects that the objective was to increase the awareness of STEs about SaaS solutions potential instead of succeeding in integrating a new solution into a business process.

A framework represented in Figure 20 is proposed to facilitate the duplication of the platform. It links the main features of the second platform through the different lens of the knowledge management theory. An internet link to a GitHub repository is also provided with instruction for duplicating and setting up a similar platform (Cavillier 2018).

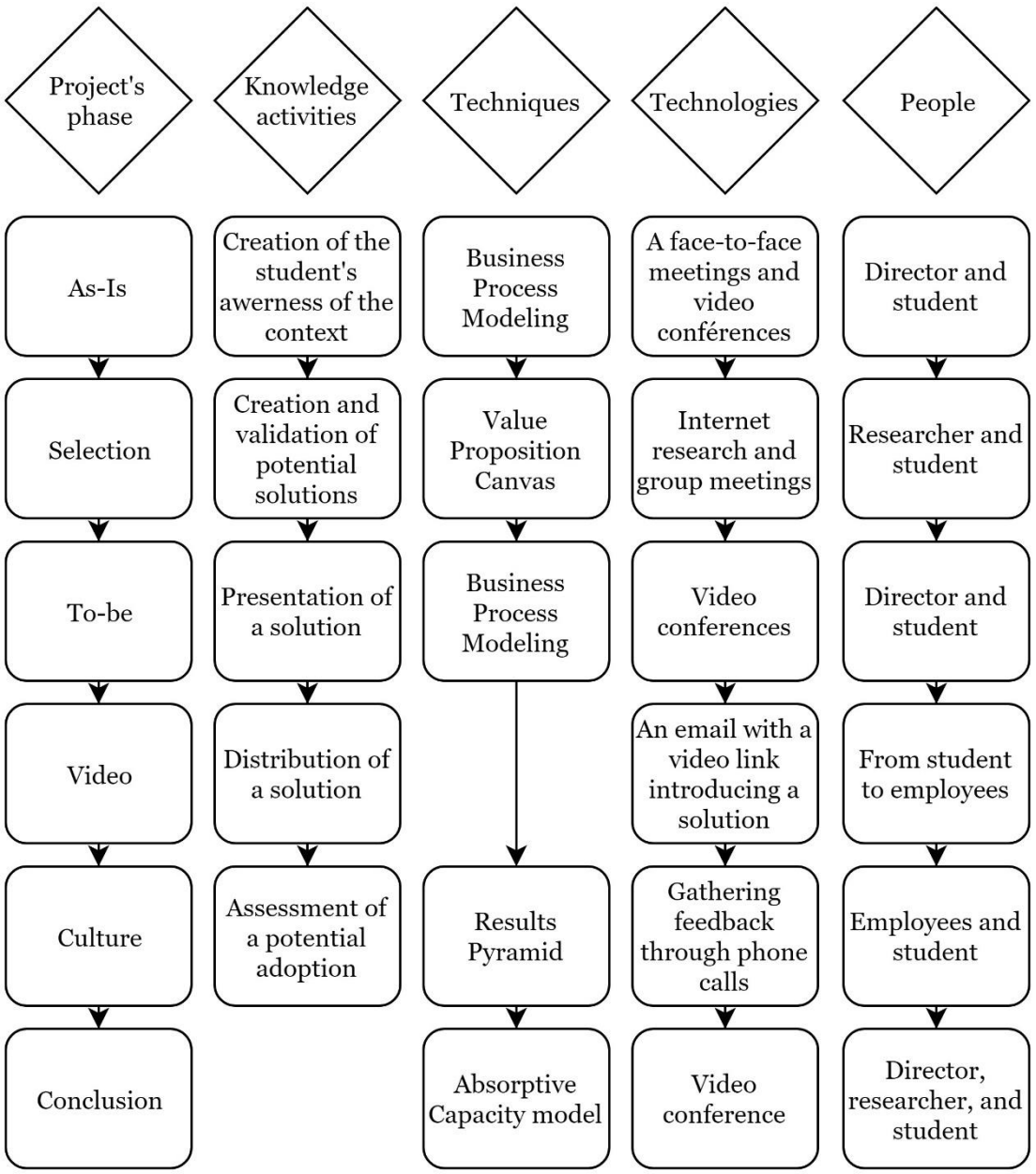


Figure 20: Framework of an open innovation platform used to manage collaborative projects between students and STEs

Nonaka (1994), with his famous dynamic theory for organizational knowledge creation, defines interactions between individuals as the foundations for knowledge creation. To illustrate this knowledge creation process, Nonaka proposes the SECI model, standing for socialization, externalization, combination, and internalization, which are four different activities leading to the creation of either tacit or explicit knowledge within a company. Through this research, the findings validate the

Desouza' and Awazu' (2006) claim about the STEs' inclination to solely apply socialization to acquire new knowledge. However, the research has also demonstrated the high students' intrinsic motivation toward knowledge externalization and internalization with activities such as drawing models or testing applications.

Combination of knowledge has not been properly explored during the research because of the need to understand which knowledge to produce on the platform. Further research might explore different approaches such as machine learning to combine knowledge of different projects to provide custom advice either to improve students' soft skills or to highlight potential process improvements. It should also be seen as an opportunity for researchers to develop new methods to combine knowledge. Figure 21 represents the roles of the different stakeholders on the platform within the Nonaka's model.

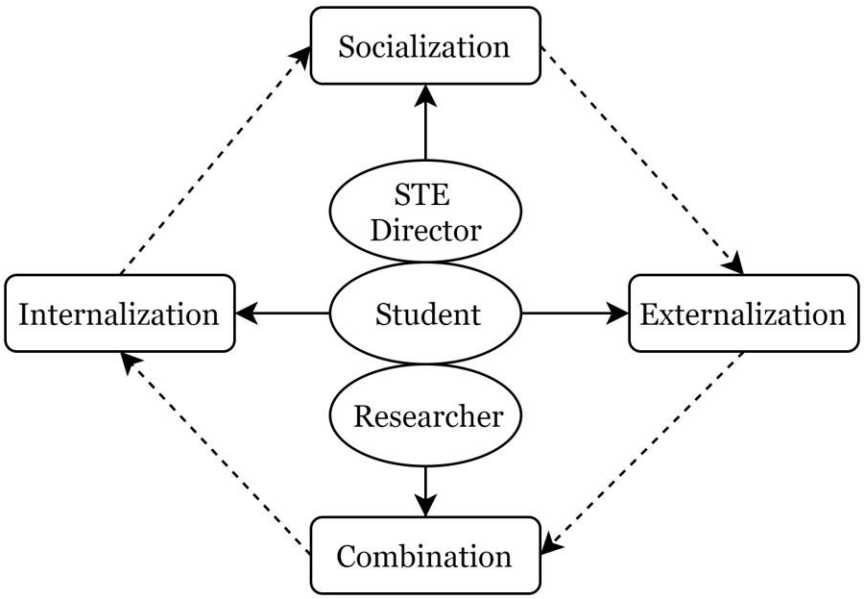


Figure 21: Roles of the platform's stakeholders in the knowledge creation process defined by Nonaka (1994)

Therefore, STEs' weaknesses seem to be a perfect match with academia's strengths. Chapter 5 will discuss the different contributions and opportunities created by this research for academia and STEs.

Chapter 4.

Small Firm characteristics

Even though research on ICTs adoption by STEs is a phenomenon that produced many researches from different perspectives (digitalisation of operational processes, customer relationships, or workforce engagement), it remains unclear what are the key factors affecting the digital transformation of STEs. First, studies are usually focusing on high-tech small firms or manufacturing medium firms. Second, qualitative researches have highlighted dozens of specific factors using grounded methods while quantitative ones have only assessed a few main factors using technology-oriented models (Alshamaila et al. 2013; Lucchetti and Sterlacchini 2004). Neither qualitative and quantitative studies have attempted to apply theories of organizational behaviour such as Intellectual Capital, Dynamics Capabilities, Organizational Culture, and Absorptive Capacity. Therefore, this chapter attempts to build a comprehensive overview by assessing those factors through a mixed methods research under a conceptual framework gathering these organizational theories. Furthermore, this research took place after the one presented in Chapter 3 because of a need to improve our understanding of the key factors influencing STEs' digitalisation. The objective was to use the results of this chapter to propose an improved version of the platform concept presented in the previous chapter.

4.1. Research design

The idea of designing this research started with the students' difficulties to apply the absorptive capacity model to STEs to assess their potential barriers to adopting new digital solutions (see Chapter 3). Learnings of the previous chapter pointed out STE directors' behaviours as the key enabler for the adoption of solutions. However, the assessment of the other organizational factors presented in the absorptive capacity model did not receive enough attention because of the focus on improving the collaboration between students and STE directors. Thus, this study will provide a deeper analysis of the organizational factors affecting STEs' digital transformation. The starting point of this research was a review of the different

organizational theories related to the firm's innovation performance. A first review of the literature about the firm's absorptive capacity reveals two other organizational theories that are related to the firm's innovation: the dynamic capabilities, and the intellectual capital. Three short discussions sum up the current state of the literature for these three theories and demonstrate the validity of this research. Then, a conceptual model is presented as an attempt to combine these different theories to develop a detailed analysis of all the potential factors that might impact STEs' digital transformation. It should help to validate our previous findings about the importance of top management, and it should also shed some light on the interdependences among the factors.

4.1.1. Absorptive Capacity

Cohen and Levinthal (1990) have been the firsts to define the concept of absorptive capacity as a collective *"prior related knowledge [conferring] an ability to recognize the value of new information, assimilate it, and apply it to commercial ends"*. A decade later, Zahra and George (2002) propose a reconceptualization and extension of the absorptive capacity. They define absorptive capacity "*as a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability*". Thus, absorptive capacity is not anymore only related to the level of collective prior related knowledge, it also encompasses other dimensions related to the organizational structure and culture that will affect the adoption and application of new knowledge. Lane and Koka (2006) have proposed a model with the dimensions prior related knowledge, learning relationships, firm's member mental models, firm's structure and processes, and firm's strategy as antecedents of absorptive capacity (see Figure 11 in Chapter 3, p.73).

Roberts et al. (2012) highlight, through a literature review, several gaps in absorptive capacity research. First, previous studies have mostly conceptualized absorptive capacity as an asset based on the level of prior related knowledge. As we have seen, prior knowledge is an essential but insufficient condition for absorptive capacity. Thus, a secondary purpose of this study is to assess the importance of these others absorptive capacity antecedents. Furthermore, as shown in Chapter 2 et 3, STEs have usually a little prior related knowledge about SaaS solutions, which suggest that

other antecedents are explaining the different level of absorptive capacity among STEs.

Furthermore, Easterby-Smith et al. (2008) argue that absorptive capacity theory has been mainly dominated by quantitative studies. After this article, a few studies have produced case studies but only in specific domains. Jansen et al. (2005) have emphasized that researchers tend to focus on R&D or multinational contexts. For instance, Duchek's study (2014) analysed the structural determinants of absorptive capacity for two high-tech firms. Peeters et al. (2014) studied the efficiency of different configurations of absorptive capacity routines within two multinational firms. However, with the democratisation of ICTs, it becomes interesting to also explore the firm's absorptive capacity from other sectors such as STEs. Furthermore, as absorptive capacity is defined as a dynamic capability, it is necessary to also look at the literature on dynamic capabilities to assess the potential effect of other capabilities on STEs' digitalisation.

4.1.2. Dynamic capabilities

Through a review of the literature, Wang and Ahmed (2007) define dynamic capabilities "*as a firm's behavioural orientation constantly to integrate, reconfigure, renew and recreate its resources and capabilities and, most importantly, upgrade and reconstruct its core capabilities in response to the changing environment to attain and sustain competitive advantage*". By this definition, they empathize the embedded nature of dynamic capabilities within processes. In other words, dynamic capabilities are not simply processes that can be easily duplicated within or across a company, they are also tacit elements – such as know-how and leadership – that will make the operationalization of the processes efficient.

With a Fuzzy Cluster Analysis of 62 articles, Lin et al. (2016) establish four components of dynamic capabilities named: sensing capability, relational capability, integrative capability, and absorptive capacity. Figure 22 classifies these three capabilities and absorptive capacity according to their external or internal focus and their relationship with the sensemaking or sensegiving abilities.

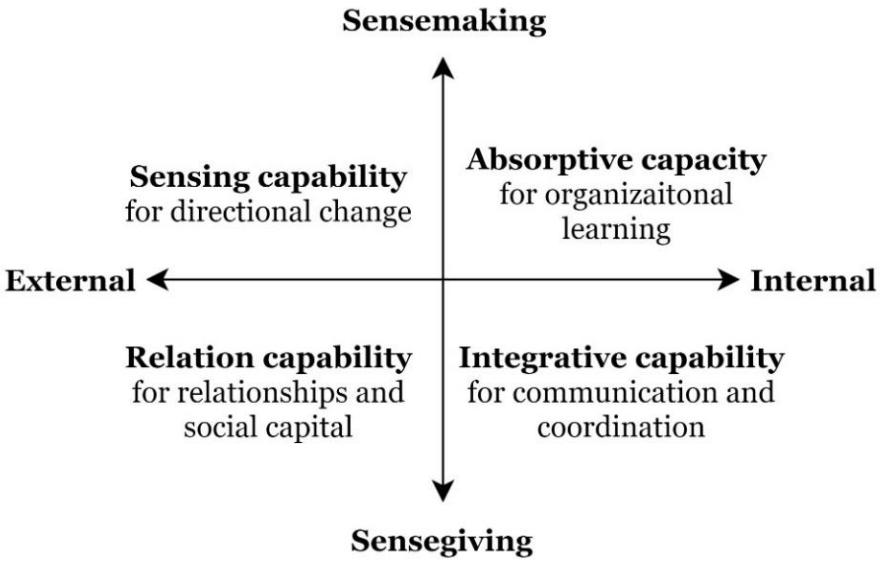


Figure 22: Components of dynamic capabilities (Lin et al. (2016))

Interestingly, dynamic capabilities seem closely related to leadership through the concepts of sensemaking and sensegiving. Gioia and Chittipeddi (1991) were the firsts to highlight the key role of developing the appropriate sensemaking and sensegiving abilities of leaders for strategic change initiation. Related to SMEs' context, Dutta and Thornhill (2014) demonstrated the importance of appropriate sensemaking and sensegiving for 30 entrepreneurs that managed venture growth over five years. Gäre and Melin (2011) explored the value of formative infrastructures to develop adequate SMEs' sensemaking for business transformation. Thus, developing the adequate dynamic capabilities of STE directors seems essential for the firms' ability to survive and innovate (Matzler et al. 2008; Sharifi and Zhang 2009).

However, dynamic capabilities should not be seen as the unique factor affecting the firm's innovation. Intellectual capital of a firm has been connected to dynamic capabilities as a second important factor for competitive advantage and innovative performance (Beattie and Smith 2013; Han and Li 2015)

4.1.3. Intellectual capital

Nahapiet and Ghoshal (1998) propose a definition for the intellectual capital that refers to *"the knowledge and knowing capability of a social collectivity, such as an organization, intellectual community, or professional practice."* The term knowing capability also refers to the concept of absorptive capacity through the

processes of acquisition, assimilation and transformation of external knowledge. Therefore, the absorptive capacity and the intellectual capital of a firm seems closely related, which also empathize its relationships with dynamic capabilities.

Thus, the intellectual capital of a firm is not simply assessed through the level of knowledge from employees. Intellectual capital is built on human, structural and relational capital. Figure 23 discloses a model of intellectual capital presented by Edvinsson and Sullivan (1996).

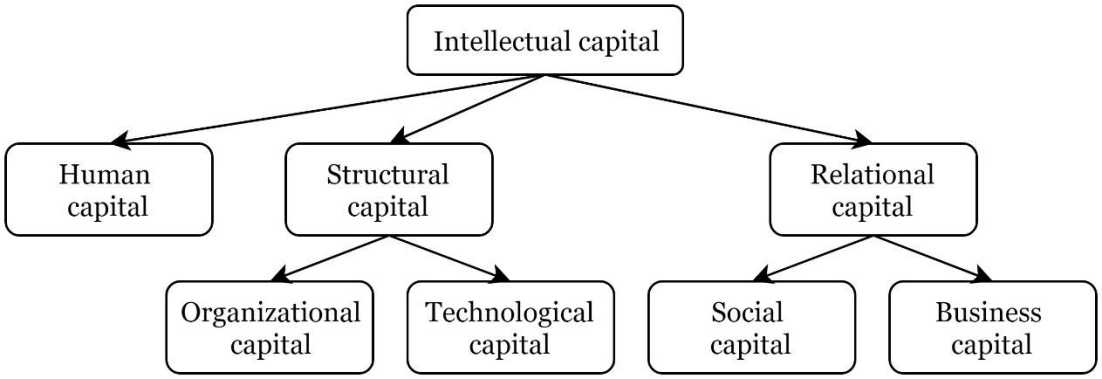


Figure 23: The intellectual capital dimensions (Edvinsson & Sullivan, 1996)

Human capital encompasses characteristics of the firm's members and their knowledge. Structural capital is physical or virtual infrastructures (e.g., ICTs, desks) that foster creative and productive thoughts. Relational capital covers all kind of relationships within and outside the firm that add value to the intellectual capital. For instance, social capital is considered as a facilitator for the creation of intellectual capital because of fostering knowledge transfer and combination (Nahapiet & Ghoshal, 1998). Business capital refers to strategic alliances and inter-organizational relationships that may bring external knowledge.

A short review of the intellectual capital literature helped us to identify four gaps that are supporting the value of this research. First, the influence of intellectual capital on firms' performance has been recognized through many empirical studies (Inkinen 2015; Subramaniam and Youndt 2005). However, only a few studies have explored the effect of intellectual capital on innovation within SMEs, with a focus on product innovation (Chen, James Lin, and Chang 2006; Hsu and Fang 2009). Following Leitner's recommendation (2015), this chapter explores the innovation of business processes through the adoption of digital solutions such as ERP, CRM, and KMS.

Secondly, intellectual capital has been defined as a combination of human capital, structural capital, and relational capital – also called social or customer capital (Martín-De-Castro et al. 2011). However, findings about the importance of intellectual capital components in firms' innovative performance differ across the studies. Cabello-Medina et al. (2011) highlighted the combination of social and human capital as main drivers for a firm's innovative performance, whereas Costa et al. (2014) explained that structural capital fosters innovative performance. Bontis et al. (2000) underlined that the results partly differ according to the sector, which implies that findings for a specific sector – such as manufacturing or high-tech businesses – are not generalizable to more traditional sectors, such as construction, dealership, and agriculture. Thus, assessing the intellectual capital aspect of STEs help to complete the literature.

Thirdly, intellectual capital studies tend to explain firms' innovative performance without looking at other organizational behaviour theories. Only a few researchers have attempted to connect intellectual capital theory to other streams of literature related to innovation in firms such as dynamic capabilities, absorptive capacity, and organizational culture (Engelman et al. 2017; Hsu and Wang 2012; Sánchez-Cañizares et al. 2007; Wu, Lin, and Hsu 2007).

Fourth, an emergent movement in the intellectual capital literature claims that past empirical research mainly focused on reporting the benefits of different intellectual capital components on a firm's performance, without paying sufficient attention to the difference between intellectual assets and intellectual liabilities (Dumay 2013). Stam (2009) explained that intellectual liabilities should be interpreted "as potential non-physical causes of organizational deterioration". By contrast, intellectual assets should yield future benefits to a company. Organizational inertia seems an appropriate proxy for intellectual liabilities (Pearse 2009). Organizational inertia has recently received renewed interest from researchers, and different types of inertias have been defined: political, structural, psychological, cultural, and economic (Haag 2014; Schmid, Recker, and Vom Brocke 2017).

Thus, after having reviewed these different works of literature on firm's innovation, a conceptual framework gathering these four dimensions – such as dynamic capabilities, absorptive capacity, intellectual capital, and organizational inertias is proposed.

4.1.4. A conceptual framework

An approach to depicting the relationship between intellectual capital and dynamic capabilities is to look at different interpretations of intellectual and intangible characteristics in a firm. For instance, Caddy (2000) defined "intellectual assets" as various combinations of intangible assets, and Petty and Guthrie (2000) also delineated intellectual assets as part of the firm's intangibles. Although the two terms, intellectual and intangible, are often considered similar, we propose a distinction based on recent findings of the relationship of reciprocity between dynamic capabilities or intellectual capital. On the one hand, Singh and Rao (2016) highlighted the positive effect of intellectual capital components on dynamic capabilities such as learning, integration, reconfiguration and alliance management. On the other hand, those dynamic capabilities have also demonstrated a mediating effect on intellectual capital (Hsu and Wang 2012; Wu et al. 2007).

Furthermore, recent items used for assessing intellectual assets seem closely related to organizational culture, learning routines, employee behaviour, and relational management practices (Ansari et al. 2016; Sharabati, Jawad, and Bontis 2010). These elements are components of dynamic capabilities (Chirico and Nordqvist 2010; Hung et al. 2010).

To enhance our understanding of the relationships between intellectual capital and dynamic capabilities, we can develop the definition of Eisenhardt and Martin (2000). They define dynamic capabilities as "organizational and strategic routines by which managers alter their resource base [...] to generate new value-creating strategies." From our perspective, the resource base in this definition comprises the intellectual assets that make up the intellectual capital of a firm.

Drawing upon this observation, Figure 24 proposes a conceptual framework connecting dynamic capabilities to intellectual assets. In the model by Lin et al. (2016), dynamic capabilities are composed of capabilities related to sensing, relating, absorbing, and integrating, which can easily be linked to intellectual assets. This linkage enhances the perception of the two theories as compatible. Finally, leadership is considered as a driver for organizational culture changes (Cameron & Quinn, 2006). It has also been highlighted by empirical research as a key factor for SMEs' digital transformation (Barba-Sánchez et al. 2007; Marcati, Guido, and Peluso 2008). Thus, leadership should definitively be part of the conceptual framework.

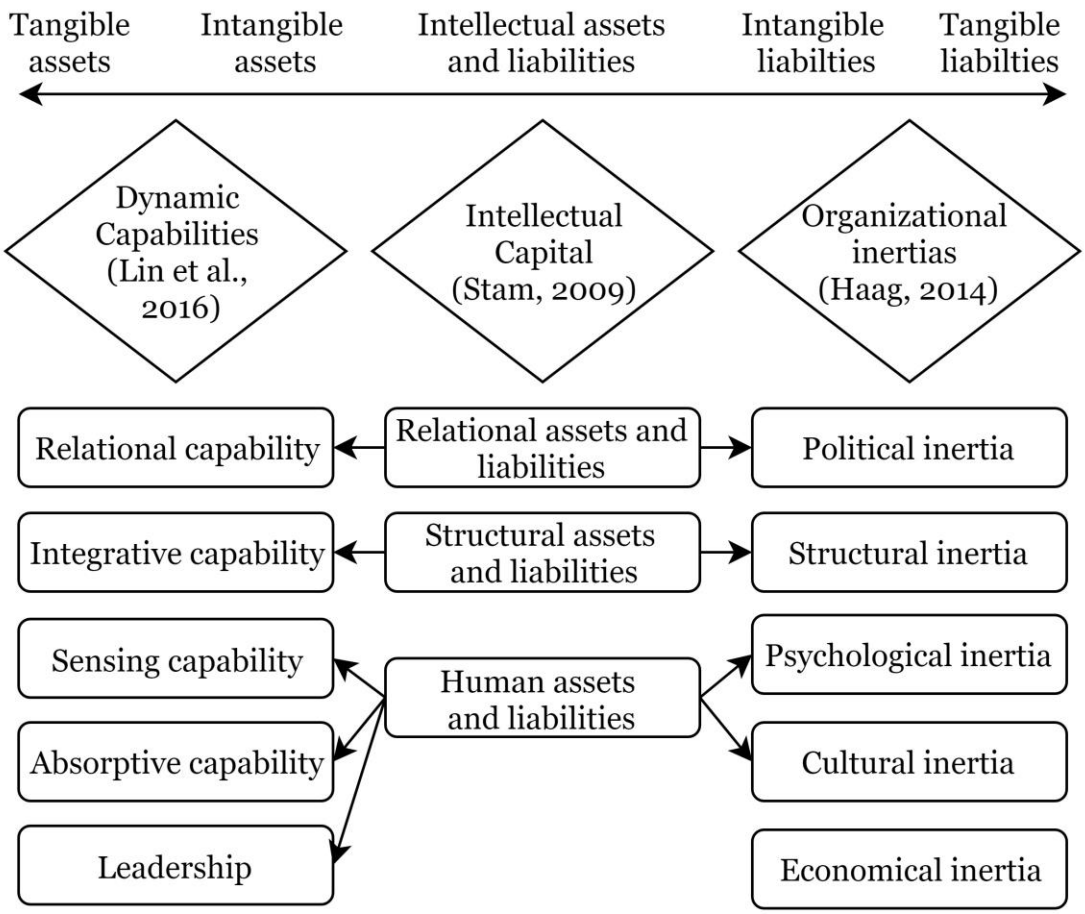


Figure 24: A multilevel model connecting intellectual capital, dynamic capabilities, and organizational inertias

The right part of Figure 24 shows how different organizational inertias are related to intellectual liabilities. Economic inertia is not considered in intellectual capital literature because of its tangible nature. However, we retain this inertia in our model because a lack of resources is highlighted in the literature as being a barrier to innovation in SMEs (Harindranath, Dyerson, and Barnes 2008).

The dynamic capabilities and organizational inertias are positioned between the intangible and tangible levels. This is because some of their components possess a countable nature. For instance, relational capability can be measured through the number of times a firm participates in external networking events. Using our theoretical model, we aimed to develop an initial weighting system for the various components regarding the adoption of digital solutions by STEs.

To the best of my knowledge, this conceptual framework is a first attempt to combine these three streams of literature, intellectual capital, dynamic capabilities, and organizational inertias, under the two intangible dimensions.

4.1.5. Methodology

One of the contributions of this chapter is the application of mixed-methods research to assess STEs' situation in facing digital transformation. Although mixed-methods research is called the “third methodological movement” (or paradigm), empirical studies generally follow the second movement, which means applying qualitative or quantitative research separately (Venkatesh, Brown, and Bala 2013). This chapter supports the third movement by demonstrating the value of mixing qualitative observations with quantitative data, to reveal the true meaning of the results. An important design criterion in the mixed approach is the choice of prioritizing either qualitative or quantitative analysis (Ivankova, Creswell, and Stick 2006). As the study objective was to define the true causes of the relations amongst the intangible factors, the multiple case-study analysis forms the core of this chapter, with quantitative results being presented to support or refute the qualitative observations.

Figure 25 describes the sequential approach. The qualitative findings helped to define the sampling frame to construct the survey. In turn, the survey results were used to test the validity of the qualitative findings and to enhance the depth of the findings and conclusion (Teddlie and Yu 2007).

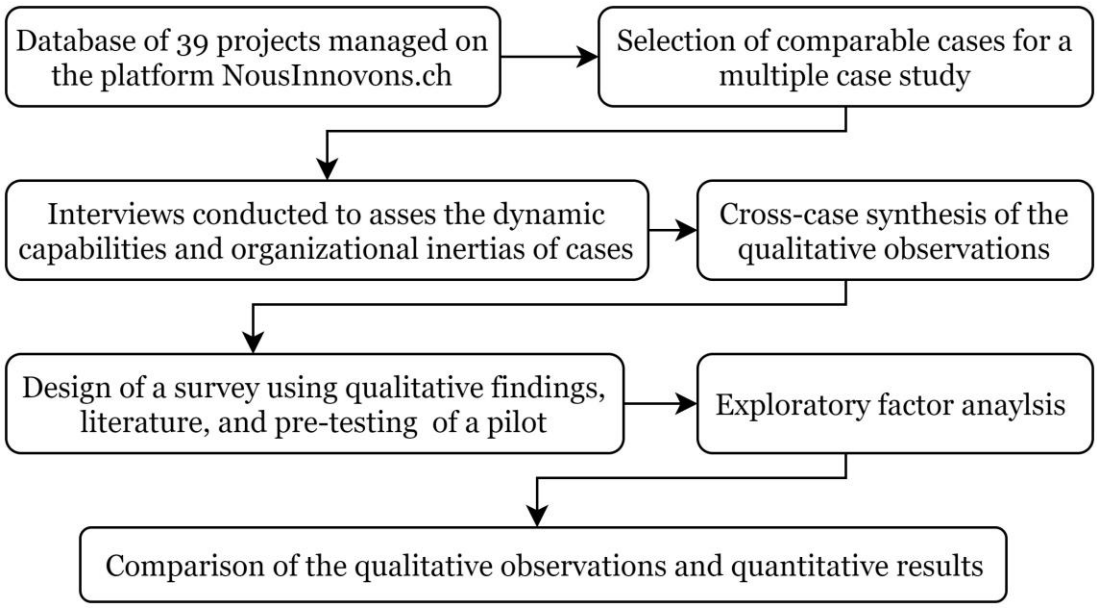


Figure 25: Sequential mixed-methodology approach for exploring the organizational factors affecting STEs’ digitalisation

The case studies in this qualitative analysis were a selection of 29 firms that participated in action research for designing a digital platform to increase STEs' awareness about digital transformation opportunities (reference hidden for the review process). The platform connected students of engineering to STEs, to give the students an opportunity to analyse the firms' situation and propose process optimizations with web applications sourced from the internet. A three-month project was set up, with interviews of STEs being conducted by the students every two weeks. A multiple case-study analysis was built from a selection of 11 case studies. Each firm met the following requirements: 1) the firm's size was between 20 and 80 employees, 2) the STEs were not working in the ICT field, 3) they had been created more than 10 years ago, 4) a real potential for digitalisation was identified during the project, and 5) the solution proposed was easy to implement without the need for much training. These strong selection criteria were necessary to ensure a proper sample of STEs, in other words, a sample with only small firms from traditional sectors that are not start-ups and with a true opportunity to start a digital transformation.

The purpose of interviewing the 11 participants was to assess the dimensions presented in Figure 24, which impacted the adoption of the student's solution. Then, using a cross-case synthesis, key organizational behaviours for the digitalisation of STEs were proposed. These ideas shaped the design of a survey for the second part of the mixed-methods research.

4.2. Qualitative research

The research design followed the recommendations by Yin (2017). He identifies three criteria for judging the quality of an exploratory study, namely construct validity, external validity, and reliability.

Construct validity refers to the formulation of the correct measures and concepts to be studied. In our multiple case-study analysis, the main concept observed was the STE's behaviour towards potential process optimization. By participating in a project to identify potential business process improvements, each STE's overall absorptive capacity was observed through the company's ability to test the student's solution and give proper feedback. Furthermore, BPM made by students were useful to gather insights about the integrative capability and structural inertia. Then, the remaining dimensions were explored through interviews with directors. The level of

digitalisation was assessed at the beginning of the project through a review of the firm's current structure.

The use of three sources of evidence allowed for the triangulation of the different measures. First, the students had to apply different models to analyse the STE's situation during their project; the models included business process models (Freund and Rücker 2012), a value proposition canvas (A Osterwalder et al. 2014), and a results pyramid model (Connors and Smith 2011). These models were validated by the STE's directors afterward. The project reports based on these models were the first source of evidence. Weekly feedback from students was used as the second source of evidence. The students gathered observations from approximately four to six meetings with directors during their project. Third, to review and complete students' observations, I conducted semi-structured interviews with the directors several months after the end of the project.

Yin suggested properly defining the replication logic to demonstrate the external validity of a qualitative study. This replication logic was applied through the action-research methodology used to develop the digital platform, from which the case studies were produced. Four rounds lasting six months were dedicated to test and to improve the protocol and the platform's design used by students to analyse the STEs. Each round was structured on the iterative process of "Look – Think – Act" described by Stringer (2007). This process and the platform's modification resulting from previous rounds of observations are summarised in Chapter 3. The path followed by the platform's evolution demonstrates the efforts made to reduce potential selectivity due to preconceived ideas.

Finally, the reliability of the research was ensured through the standardization of the procedure followed by students to lead projects on the platform. A project plan with weekly objectives was provided to every student at the beginning of the project. At the end of the project, gathering all the data according to our conceptual framework produced a reliable database to perform a cross-case synthesis.

4.2.1. Sampling

Table 28 discloses the 11 firms, the project's objectives, and the general assessment of the companies' absorptive capacity. The 11 cases provided a sufficient sample of STEs having different intellectual capital. For instance, firms with engineers (Eco, Cit, Alp, and Tig) were assumed to have a relatively high human capital. Firms

such as Pro, Ste, Bol, and Ati, were assumed to have relatively low structural capital because they did not show standardized processes, information system, or ERP solutions. A strong relational capital was identified among the firms Pro, Vic, Alp, and Tig because of their need to closely collaborate with partners, suppliers, and clients. The adoption behaviour was mainly assessed through the level of participation from the STEs in the different phases of a student's project to define a solution to digitalize a process in the firm.

Table 28: Description of the 11 firms composing the multiple case-study analysis

Firm	Sector	Size	Type of solution	Adoption behaviour	HC	SC	RC
Pro	Agricultural dealership	20	Information sharing	Strong	-	-	-
Ste	Construction	20	Resources management	Strong	-	-	-
Eco	Environmental engineering	25	Information sharing	Strong	+	+	-
Cit	Urban Engineering	60	Project data sharing	Medium	+	+	-
Bol	Construction	25	Information sharing	Medium	-	-	-
Vic	HR consulting	45	Reporting process	Medium	-	+	+
Alp	Industry	50	Reporting to clients	Medium	+	+	+
Ati	Construction	30	Resources management	Medium	-	-	-
Tig	Civil Engineering	20	Issues reporting	Low	+	+	+
Rit	Construction	70	Tasks sharing	Low	-	+	-
Tap	Construction	80	Tickets management	Low	-	+	-

Table 28 reveals that firms displaying strong adoption capabilities did not necessarily possess strong human, structural, and relational capabilities. Therefore, as a preliminary finding, it seems that intangibles such as dynamic capabilities and organizational inertia are playing a more important role than intellectual assets in STEs' digitalisation.

4.2.2. Results

Interview questions were designed by blending the absorptive capacity model proposed by Lane et al. (2006) and intangible components defined in Figure 24. Even if absorptive capacity is defined as a component of dynamic capabilities, we believe that the six absorptive-capacity factors defined by Lane et al. can be extended to the assessment of additional intangibles. The factors defined by Lane et al. are environmental conditions, knowledge characteristics, learning relationships, employees' perceptions, firm structure, and firm strategy. The project's observations and interview answers were gathered and classified under four of these six factors because environmental conditions and knowledge characteristics did not appear to influence STEs' digital transformation.

For most companies, the motivation to transform was mainly due to internal reasons rather than environmental conditions. No constraints due to political inertia from partners or customers were highlighted as reasons to avoid digital transformation. Furthermore, as all the solutions proposed by the students for the 11 cases were quite similar and required only basic knowledge about the internet and computer usage, specific knowledge characteristics were not found to be a main driver or barrier to testing solutions.

For the four remaining drivers, Table 29 provides short comparisons of the 11 cases regarding the firm's strategy and structure, employees' perceptions, and learning relationships. In the context of small firms, the level of strategy is assessed through leadership actions performed by directors to support the research, testing, and adoption of new digital practices. It encompasses the sensing and leadership capabilities. Firm's structure refers mainly to the business processes, internal relationships, or current systems that act as barriers or facilitators for change. This corresponds to the integrative capability and structural inertia. For instance, a firm's structure fostering team working will have a high integrative capability for change,

when a firm's structure using systems hard to customize will have strong structural inertia. Perception is related to the employees' beliefs and the firm's culture regarding digital transformation. This empathizes either a high absorptive capacity or a strong cultural or psychological inertia. Finally, learning relationship refers to any ties that help STEs to acquire and understand new knowledge about digital transformation, which is the relational capability. Thus, Table 29 sums up all the observations of the 11 cases under four columns that are related to the dimensions of Figure 25. Dimensions are classified from strong to weak levels, where a strong level means the predominance of a dynamic capability over an organizational inertia, and a weak level the opposite.

Table 29: Analysis of the intangible assets and liabilities of 11 STEs

Firm	Firm strategy	Firm structure	Employees' perceptions	Learning relationships
Pro	Strong: The director collaborates with a consultant to develop his business skills.	Weak: "We lacked rigour to communicate about the changes."	Weak: "Old routines slowed down the adoption".	Strong: Participate in a governmental program.
Ste	Medium: Key manager is open-minded and responsive to new solutions.	Strong: Key processes are managed by a small team with strong ties.	Weak: "Our old field workers do not see the value of IT solutions".	Strong: Share with other directors from an association of professionals.
Eco	Strong: Directors have regular meetings to try new solutions.	Medium: Engineers work outside, but they meet once a day.	Medium: The workload reduces the employees' involvement.	Strong: "We attend professional networking events".
Alp	Medium: Applies ISO guidelines.	Weak: "We want to keep using the current system."	Strong: "Everyone wants a solution to avoid unpaid overtime".	Medium: Have an IT team for R&D.
Vic	Medium: A new associate director pushes to digitize the firm.	Weak: Consultants rarely meet with each other.	Weak: Managers are used to being independent.	Medium: "I am testing solutions for clients".

Cit	Medium: Only the director seeks occasional innovation.	Weak: No information sharing between small teams.	Medium: Strong digital knowledge but a focus on production.	Medium: Research by the director and a consultant.
Bol	Weak: A director tests solutions during lunch breaks.	Strong: Key processes managed by a small team.	Weak: Older employees perceive IT as too complex.	Weak: Research is done by a director who likes technology.
Ati	Weak: We are "moving the responsibilities to younger shoulders".	Medium: Lack of rigour but strong intergenerational aid.	Medium: New systems are the responsibility of the young employees.	Weak: Wait for a proposition of a consultant to decide about any change.
Tig	Weak: "It is hard to find enough time."	Strong: Small structure working in teams on projects.	Medium: "It is not the older employees that are reluctant to change".	Weak: Do not need because "new trends spread quickly in our business".
Rit	Weak: Directors are passive about initiatives from young employees.	Weak: Departments are in different offices with their own culture.	Weak: "Technicians use emails for decades and do not want to change".	Weak: Only a young employee is looking for potential solutions.
Tap	Weak: "We did not have the time to support the adoption"	Weak: Employees are separated by ages in different offices.	Weak: "There is a gap between generations".	Weak: "A friend showed me a solution".

Table 29 provides insights into the importance of the various factors affecting the adoption behaviours of STEs. Three firms – Pro, Ste, and Eco – demonstrated good adoption capabilities, mainly related to their strong relational capability to build and maintain learning relationships. Interestingly, firms with strong relational capital were not necessarily the ones with strong learning relationships. In other words, STEs that have the possibility to acquire new knowledge from their clients or partners networks are not necessarily the ones with the best learning relationships because of a poor relational capability. It appears that directors of the three firms with a strong adsorptive capacity were proactive to look for professional or governmental events to

develop their learning relationships. Another important aspect of the three firms was their small size (up to 20 people), which allowed them to respond more easily to testing a solution compared to larger firms.

Furthermore, constant support from the STE's directors seemed to be a crucial point for succeeding in any digital transformation. Despite Tig, Rit, and Tap validating the value of a solution to improve one of their business processes, they failed to properly test the solution. A lack of leadership from directors was highlighted as the main cause of these failures. Instead of encouraging and supporting employees to take time to test the solutions appropriately, they waited for workers to test the solutions by themselves. Furthermore, a lack of sensing capability was observed for the firms Ati and Rit through the low interest from directors to truly learn about the students' solutions. For both cases, directors were considering that new digital practices were not their concerns but the concern of younger generations. From a methodological perspective, only Pro tried to apply a structured strategy to analyse and innovate its business processes. Among the other firms, process optimization was based on the directors' feelings about potential opportunities. None of the firms was able to identify strong key performance indicators to assess the value of new digital practices.

The firm's structure did not seem to halt the adoption of digital practices. However, in some cases, the firm's structure appeared to be a factor that slowed down such adoption. For instance, Vic and Alp had developed structural rigidity because of their wish to conserve their current solution and to centralize everything into one platform. Other firms – such as Vic, Cit, Rit, and Tap – faced difficulties in testing and spreading new digital practices, because of a silo culture where employees were not used to sharing aspects of their work.

Criteria such as the employees' age and workload pressure were claimed by directors to be reasons for employees' poor perception of the value of digital transformation. Mixing young and old employees seemed a good strategy to improve the overall perception. It also allowed younger workers to feel more important within the company and it altered the intergenerational relationships in the firms.

Given the above findings, leadership and learning relationships were identified as the main drivers for digital transformation. The firm's structure and employees' perceptions generally produced organizational inertia that resisted transformation. A survey was designed to test the validity of these qualitative observations.

4.3. Quantitative research

The survey's purpose was to bring some weight to the different factors highlighted in the qualitative research and found in the literature. The items on the survey were adapted from surveys assessing either dynamic capabilities, organizational culture, or organizational inertia. The intellectual capital dimensions were not evaluated as it has been highlighted with the qualitative studies that they were not the real trigger for STEs' digital transformation. Finally, as the study is following an exploratory approach about the potential impact of organizational factors on STEs' digitalisation, no hypothesis was defined.

4.3.1. Survey items

For the first part of the survey, control variables such as firm size, respondent's position, number of respondent's years of experience, and firm's sector were asked to ensure the comparison of the data. Then, three multiple-choice items were designed to assess the level of digitalisation of the STEs (see Table 30). Each item was assessing the level of digitalisation in a specific domain of the STE – such as operational processes, customer relationships, and workforce engagement. Following these items, an open question was requesting the solutions' names adopted by STE. The names were gathered under a public list shared among respondents. Thus, a parallel objective of the survey was to increase the STEs' awareness of digital transformation by creating a benchmarking tool.

Table 30: Three multiple-choice items assessing the STE's level of digitalisation

Digital area	Three multiple-choice items for assessing the level of digital transformation
Business process	DT1: In our organization, our processes… have greatly been automatized (ERP, accounting software, etc.) have partially been automatized with still a few processes to improve. have been a little automatized but a lot of tasks are always done manually. are managed manually even if we think we should automatize them. are managed manually because it is impossible to automatize them.

Customer relationships	DT2: In our organization, our client relationships management… has been fully digitized (client platform, CRM, and digital marketing). has been partially digitized (e.g. an ongoing project for a client platform). had been lightly digitalized with a simple solution (e.g. Dropbox). has not been digitalized even if we think there is an opportunity. is not concerned with digital transformations.
Knowledge management	DT3: In our organization, information management and collaborative work… have been fully digitized (collaborative tools, EDM solutions, virtual office, etc.) have been partially digitalized (e.g. ongoing project for an intranet). have been lightly digitalized with basics solutions (e.g. One Drive). have not been digitalized even if we think there is an opportunity. is not concerned with digital transformation.

The second part of the survey focused on the drivers and inhibitors of STEs' digitalisation. Table 31 discloses the items for each of the four components of dynamic capabilities. The sensing and relational capabilities are adapted from Li and Liu (2014) and Lin et al. (2016). The two other components, absorptive capability and integrative capability, are assessed through two organizational culture dimensions (involvement and consistency), adapted from Denison's model (Fey and Denison 2003). The dimensions' constructs have been shortened and modified to adapt to the context of STEs, and the choice to use some items from the Denison model was assessed by ten STE directors. Based on the qualitative observations, the fifth capability, leadership, is maintained and assessed through other items from Denison's model. Items marked with an asterisk in Tables 31, 32, and 33 have generated low factors loadings during the exploratory factor analysis. In other words, they have been removed for the exploratory factor analysis afterwards.

Table 31: Construct assessing STEs' dynamic capabilities

Capability	5-level Likert Items
Sensing (Li and Liu 2014)	Sens1: We often have meetings to identify market demand changes. Sens2: We can feel the major potential opportunities and threats. Sens3: We apply structured methods to gather insights about our environment.
Relational (Lin et al., 2016)	Rela1: We often participate in events from the government or associations. Rela2: We regularly exchange with other firms about new best practices. Rela3: We systematically gather creative and knowledgeable people to innovate.
Absorptive (Fey and Denison 2003)	Abs1: Everyone believes that he or she can have a positive impact. *Abs2: People work like they are part of a team. *Abs3: People's capabilities are an important source of competitive advantage.
Integrative (Fey and Denison 2003)	Integ1: There is a clear set of values that governs the way we do business. *Integ2: It is easy to reach consensus, even on difficult issues. *Integ3: It is easy to monitor and coordinate daily tasks amongst the collaborators.
Leadership (Fey and Denison 2003)	Lead1: We have a clear strategy for the future. Lead2: We continuously track our progress against our stated goals. Lead3: We have a shared vision of what the organization will be like in the future.

As explained in the qualitative part, organizational inertias have been pointed out by many STE directors as inhibitors to their digital transformation. From the literature, five different inertias were selected: cultural, psychological, structural, economic, and political (Haag 2014; Schmid et al. 2017). Table 32 discloses the items for each inertia; these have either been picked from the literature or adapted from discussions with STE directors. Political inertia had not been observed during

qualitative research because STEs tended to focus on internal solutions with poor research to improve inter-organizational collaborations. Therefore, most were not constrained by external (political) relationships. However, to validate this qualitative observation and to ensure a full picture of the STEs' context, this inertia was included in the survey.

Table 32: Construct assessing the STEs' organizational inertias

Inertia	5-level Likert Items
Cultural (Huang et al. 2013)	CulIn1: Our organisation has a strong culture, which makes any change difficult. CulIn2: Our way of working is specific and makes any change difficult. CulIn3: When we change our behaviour, it is hard to convince others to do the same.
Psychological (Huang et al. 2013)	PsyIn1: Any change is perceived as very risky. PsyIn2: Our collaborators feel defensive when we discuss new technology. *PsyIn3: We have previous painful experiences with digital transformation.
Structural (Schmid et al., 2017)	StrucIn1: The rigidity of our current system makes it difficult for us to change. StrucIn2: The complexity of our current processes makes it difficult for us to change. *StrucIn3: We are continuing with our routines because they work well for many years.
Economical (Haag 2014)	EcoIn1: Significant investments in our system make any change difficult for a new one. EcoIn2: It is difficult to find enough resources to switch for a new information system. *EcoIn3: We must focus our resources on our core business instead of innovation.
Political (Haag 2014)	PolIn1: It is difficult to adopt any new practices if our clients/ partners are not using it. PolIn2: Our customers/partners do not want to change the way we are working. PolIn3: We rely heavily on our customers/partners to adopt a new solution.

Finally, three general factors, described in Table 33, were added, including the firm's performance, employees' age, and digital affinity. These factors are often considered important in the literature on ICTs adoption by SMEs (Arendt 2008; Kusumaningtyas and Suwarto 2015). They have also been perceived as potential digital transformation drivers by STEs respondents during the interviews. Only two items per dimension were designed because these three dimensions are assessing tangible, instead of intangible, firm's characteristics, which are easier to evaluate.

Table 33: Items for the firm's performance, collaborators' ages, and digital affinity

Dimensions	5-level Likert Items
Firm's performance	Perf1: Our company's average sales revenue is stable or grows for years. Perf2: We are confident about the enterprise' future
Employees' age	Youth1: We regularly hire young collaborators. Youth2: The average age of our collaborators is young.
Digital affinity	*Digi1: Our leaders have an affinity for new technology. *Digi2: We have geeks (people passionate about new technology) in the firm.

Thus, the survey was designed to offer an overall view of STEs' situations to compare the importance of intellectual assets and intellectual liabilities on the adoption of digital practices. The items in the second part of the survey were mixed to avoid a respondent's bias due to question order.

4.3.2. Sampling

The survey was sent three times in October 2018 to a list of 2511 e-mail addresses. From this list, 509 answers were received, which corresponds to a response rate of 20%. However, 139 responses were rejections where a link at the bottom of the e-mail had been followed to indicate a lack of interest in the survey. Because the survey was presented as a benchmarking tool in which STEs could see the names of solutions adopted by other firms, the rejection rate support previous findings of a generally low level of interest in digital transformation from STEs.

Of the 370 valid answers, 211 were retained for the exploratory factor analysis (EFA). The selection criteria were: 1) a complete set of data from the firm, 2) firms that had been established for at least five years, 3) the firm should have a minimum of 10 employees, 4) respondents should have more than one year of experience within the firm, and 5) the firm's sector should not be related to IT services. These criteria of selection were similar to the ones used for the qualitative study to enhance the validity of the comparison. Table 34 sums up the distribution of the 211 responses by firm size and sector. The 87 firms working in the construction field were architecture offices, construction firms, and other firms related to building construction. The 40 firms in the "industry" were all producing goods or products.

Table 34: Distribution of the 211 respondents by firm size and sector

Size/Sector	10-25	26-50	51-100	Total
Construction	48	22	17	87
Industry	20	11	9	40
Other	41	22	21	84
Total	109	55	47	211

The choice to conduct EFA was justified by the need to assess the combination and creation of items from various literature into a new survey. The new survey was relevant to STEs (Robin K. Henson and J. Kyle Roberts 2006).

4.3.2. A benchmarking tool

As previously discussed, the purpose of this survey was not simply to collect data on STEs' behaviours, it was also to provide a benchmarking tool to enhance the awareness of participants about solutions adopted by other STEs. Once a respondent filled in the survey, he or she instantaneously received a link to open a web page with an analysis of the results and a summary of the results provided by the other respondents. Figure 26 discloses a radar graph summing up the dynamic capabilities and organizational inertias of an STE. This representation of the different organizational factors was not reliable as, at this stage of the study, the constructs for the different factors had not been validated through factor analysis. Thus, this tool was

not developed primarily for academic purposes, but it served as a basis for quickly enhancing STEs' awareness about their current situation compared to others. The green points represent hypothetically the level of the dynamic capabilities, while the red ones are for the organizational inertias. The 10 dimensions' names have been slightly modified to improve the STEs' understanding. Openness stands for the relational capability, coordination for the integrative capability, involvement for the absorptive capacity, and mission for leadership. The same goes for the organizational inertias with relations for the political inertia, worries for the psychological inertia, and routines for the cultural inertia.

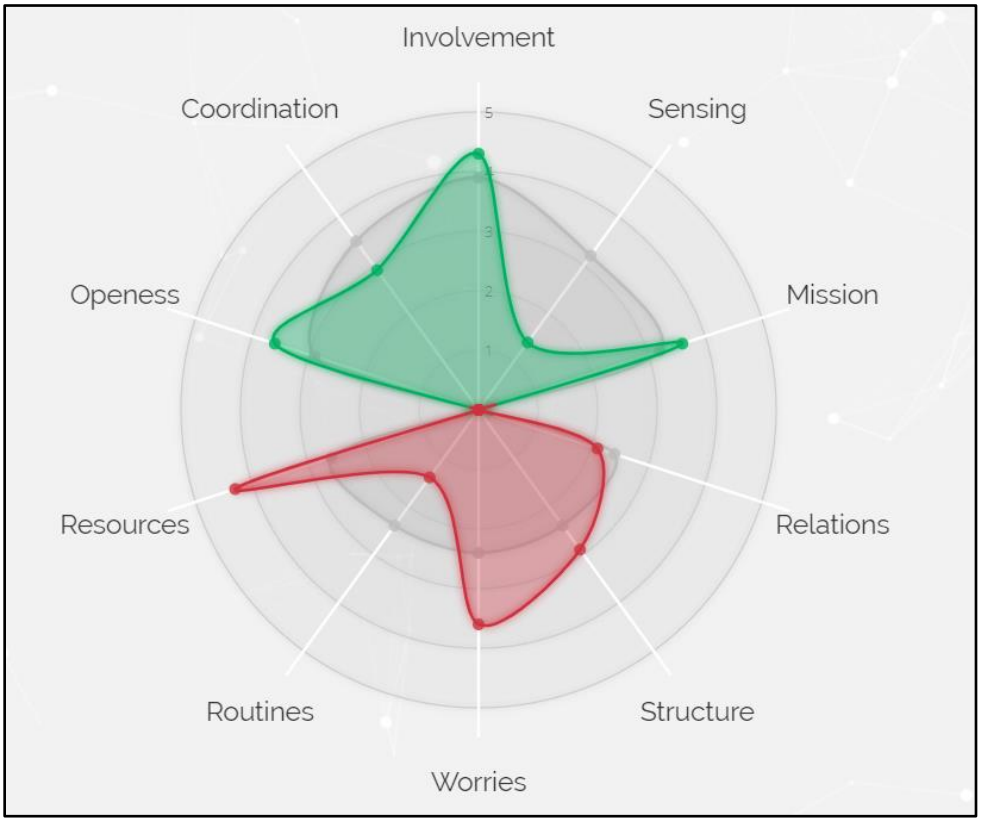
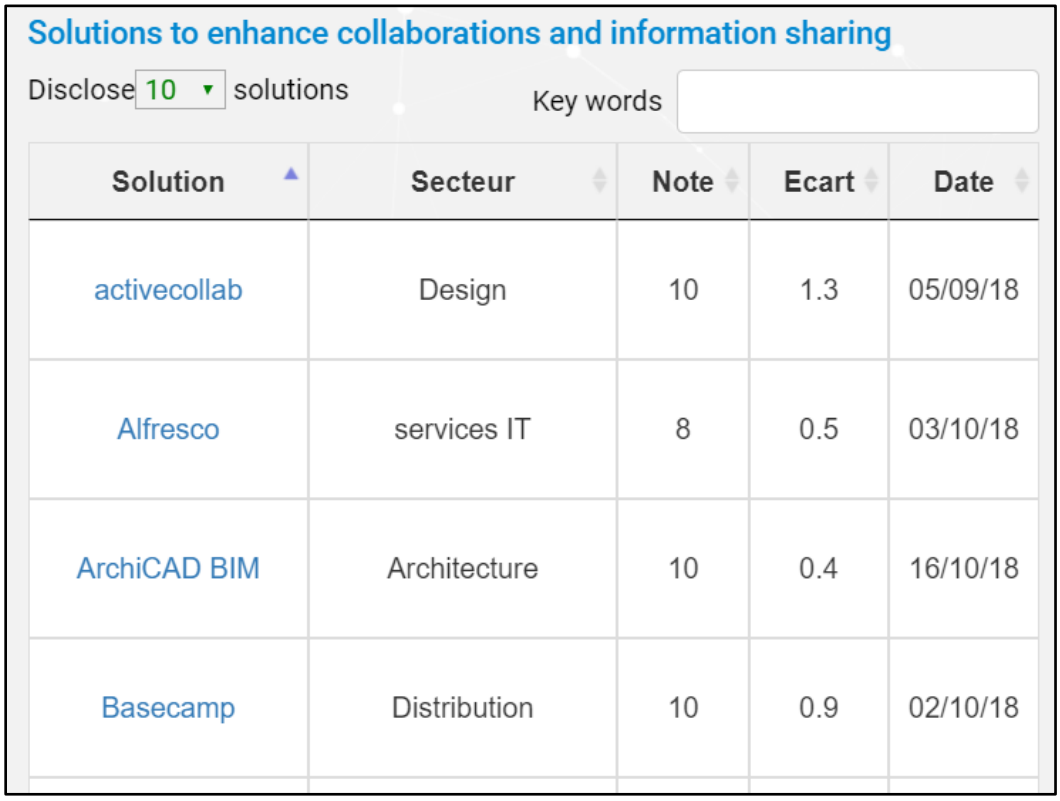


Figure 26: Screenshot of a radar graph disclosing the results of the dynamic capabilities and organizational inertias of a STE

Furthermore, three dynamic tables were listing the names of the solutions proposed by respondents according to their domain of application (operational processes, customer relationships, workforce engagement). Figure 27 discloses a screenshot of the table listing the solutions cited by STEs to improve workforce engagement through collaboration and information sharing. A total of 147 names of solutions for workforce engagement were obtained, 95 for customer relationship, and 176 for operational processes. Over the 370 answers obtained, it means that 40% of

the total of respondents proposed a solution for workforce engagement. For customer relationship, it represents 26% of the sample and 48% regarding the improvement of operational processes.



Solutions to enhance collaborations and information sharing

Disclose 10 solutions Key words

Solution	Secteur	Note	Ecart	Date
activecollab	Design	10	1.3	05/09/18
Alfresco	services IT	8	0.5	03/10/18
ArchiCAD BIM	Architecture	10	0.4	16/10/18
Basecamp	Distribution	10	0.9	02/10/18

Figure 27: Screenshot of the table listing the solutions proposed by STEs for workforce engagement

Interestingly, these high percentages are suggesting that almost half of the STEs have adopted digital solutions to improve their business process. However, a potential bias about respondents' profiles might also explain these high percentages. It is probable that STEs with an interest in digital transformation were more likely to fill in the survey than others.

Finally, tracking the number of respondents that opened the benchmarking tool empathizes the usefulness perceived by STEs of such an initiative. Overall, 292 links from different respondents were clicked to open their customized webpage, which represents 79% of the participants. However, 165 have close their webpage less than 30 seconds after its loading. The median time for the 127 others was 7 minutes, which is enough to go through all the data. 40 of the 127 have come back a few days later to look more deeply at their analysis. Thus, it appears that the tool was perceived as useful for 34% (127 over 370) of the respondents.

4.3.4. Results

The EFA was performed with the software R and PSYCH (Revelle 2017). As a first step, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were performed to validate the dataset for factor analysis (Williams, Onsman, and Brown 2010). The KMO value was 0.84, which is considered excellent, and the result for Bartlett's test was statistically significant.

The determination of an appropriate number of factors and variables was established following an iterative process proposed by Izquierdo et al. (2014). Each round of the process started with the comparison of a parallel analysis (PA) and a scree plot (SP) to establish a numerical range of potential factors. Then, a factorization for each number within the range was performed to assess the item distribution per factor. The common factor analysis was used as the extraction method because of its suitability to evaluate a theoretical model with a set of variables (Beavers et al. 2013).

For the first round, the PA suggested 6 factors and the SP highlighted 10 eigenvalues greater than 1. Thus, we ran five factorizations from 6 to 10. For each factorization, we noted which item was irrelevant, loaded low on the factors, or showed low communality. The comparison of the 5 factorizations identified 7 items to remove. First, the item Abs2 was removed because of its low factor loadings. A plausible reason lies in the work environment of STEs. We suggest that small firms naturally work in teams, independently of their predisposition to innovate, as reflected in the low matching of Abs2 with other items from dynamic capabilities. Second, the item PsychIn3 was also dropped because of low factor loadings. This highlights that previous painful experiences with digital transformation are not necessarily related to other intangible liabilities. Third, in addition to low factor loadings, the item Digi2 had the lowest score among the potential enablers of STEs' digitalisation. This result indicates that STEs usually lack employees with a strong interest in digitalisation. Fourth, the items Inte2 and Inte3 had the lowest communalities (below 0.3) combined with low factor loadings. This indicates a low matching with the various factorizations tested, which tends to support the weak impact of integrative capability on the other items. Finally, the items StrucIn3 and EcoIn3 had negative loadings with the factor assessing STEs' digitalisation. Even if these negative loadings made sense, removing the two items ensured that the level of digitalisation was assessed only by items DT1, DT2, and DT3.

After removing the seven items, a second round of factorization was conducted. The PA suggested seven factors, and nine eigenvalues above 1 were disclosed through the SP. The comparison of the models with seven, eight, and nine factors identified two more items, Digi1 and Abs3, with low loadings and high scores. As 83% of the respondents were directors and the two items assessed good leadership practices, we might argue that the high scores revealed an over-estimation of the respondents' ability. Finally, the third round provided good results, with the PA and SP recommending eight to nine factors.

After comparing the two factorizations, the nine-factor model represented in Figure 28 was chosen because it displayed results closer to our theoretical constructs. It was worth conducting three rounds of factorization to reduce the difference between the PA and the SP. We believe that the convergence of the two methods strengthens the model's validity.

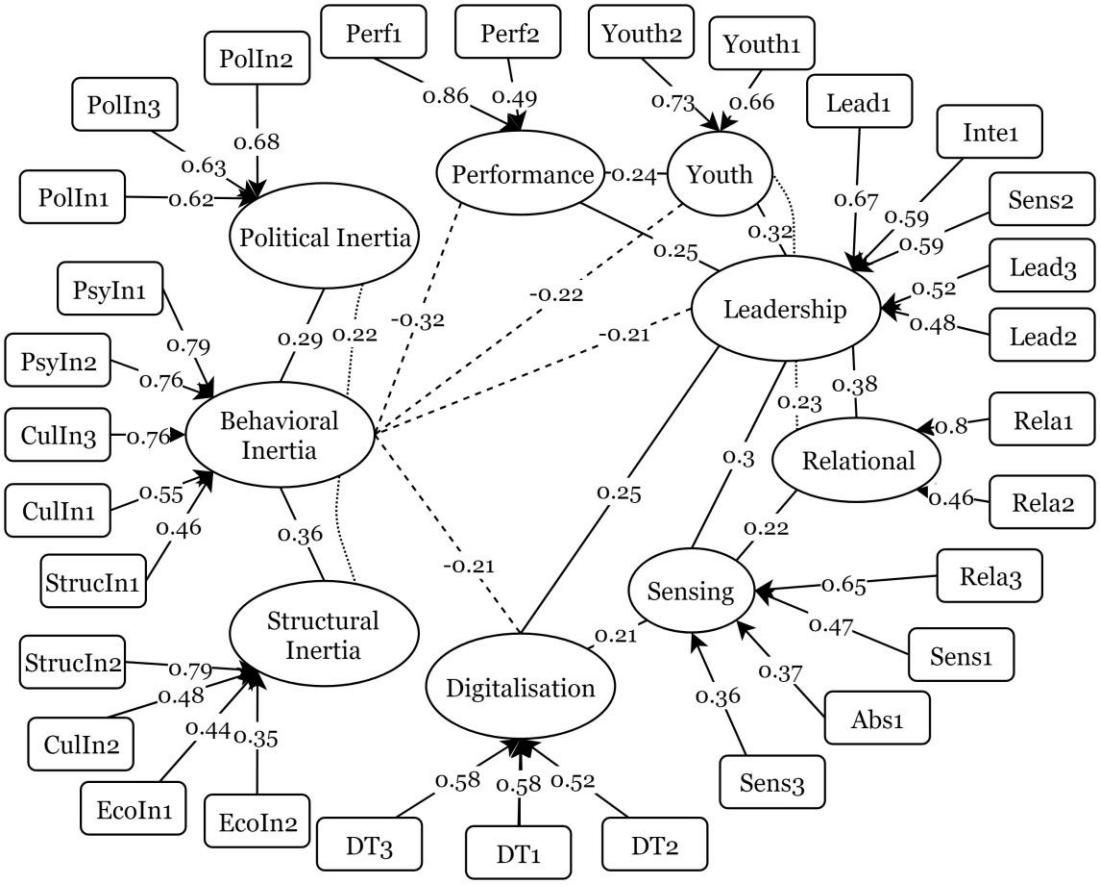


Figure 28: Exploratory factor analysis of data from 211 STEs: assessment of dynamic capability and organizational inertia

The factor names were defined through analysis of the words and themes represented in the corresponding items. For instance, the factor "structural inertia" was measured by the items StrucIn2, CulIn2, EcoIn1, and EcoIn2. Even if these items derived from different theoretical constructs, reviewing the first three revealed a common concern about job and system complexity, which creates structural inertia. Overall, eight factors over nine obtained good loadings from their items with a value usually above 0.4. Only the representation of the sensing capability might be considered as potentially inadequate due to the low factor loadings. Its highest factor is Rela3 with a loading of 0.65, which assesses the predisposition of STEs to gather creative and knowledgeable people to innovate. Combining the meaning of this item with the ones of Sens1 and Sens3 suggests that STEs with good scores for these three items are aiming to develop their sensing capability.

The coefficient of reliability was 0.72, which is considered acceptable for a model with heterogeneous constructs (Tavakol and Dennick 2011). Furthermore, a ratio of 7 responses per item follows the recommendation of Suhr (2006). In addition, 65% of the item variance was explained by the nine factors before rotation, which fits the threshold proposed by Hinkin (1998). The communalities of the variables were between 0.3 and 0.7, with an average of 0.5. This relatively low value was compensated for by the sample size being above 200 (Maccallum et al. 1999). The correlations among the factors with an absolute value above 0.2 are shown in Figure 28. Finally, the tests to assess the Model fit shown good value with 0.039 for the RMSEA index, and 0.943 for the Tucker Lewis Index (Hooper, Coughlan, and Mullen 2008; Maccallum, Browne, and Sugawara 1996).

A few main observations about Figure 28 are offered. First, the difference between the theoretical constructs and the empirical data demonstrates the importance of an exploratory rather than confirmatory factor analysis. The removal of 10 items illustrates the mismatch between items already tested in previous studies and this specific context of STEs. Furthermore, it is interesting to examine the correlations among the factors to add to our discussion about the qualitative findings. For instance, the factors of structural, behavioural, and political inertia were all strongly correlated. This can be explained by the overall bias from STE directors in considering the situation of their firm either too optimistically or too pessimistically. However, the three inertias did not have the same weights as the other factors. The negative correlations between the behavioural inertia and the leadership and digitalisation factors were interesting. It suggests that STEs with appropriate leadership practices

reduce their behavioural inertia, which improves the STEs' digitalisation. The lack of a negative correlation between structural inertia and the other factors suggests that most STEs did not see their structure as a change inhibitor. Furthermore, political inertia did not seem to act as a barrier for STEs because it had no negative correlations with other factors. Either STEs' partners were not identified as obstacles for digitalisation, or the result might reveal a tendency for STEs to evolve in silos.

Second, from a dynamic capabilities' perspective, factors that were positively correlated with STEs' digitalisation were sensing and leadership capability. The importance of relational capability should also be considered, as it correlated with the two other capabilities and item Rela3 loaded strongly on the sensing factor. The relational factor was composed of only two items and we suggest that a third should be added to improve reliability. The third item could focus on other types of supportive relationships, such as collaboration with consultants, partners, suppliers, and clients. Although item Rela3 purportedly assessed those ties, we believe it was not clear and confused STE respondents.

The correlations related to the firm's performance highlight two characteristics of STE behaviour. STE that feel confident for the future hire young people and build up strong leadership capability. However, the lack of correlation between the firm's performance and level of digitalisation raise some questions that justify a deeper analysis of our qualitative and quantitative results.

4.4. Discussion

This chapter demonstrates the value of combining statistical correlations from an EFA with observations from a multiple case study. The quantitative and qualitative data complemented each other to illustrate the essential role of leadership in fostering STEs' digitalisation. For instance, the true cause of the negative correlation between leadership and behavioural inertia is explained through a review of the qualitative research. The observations suggest behavioural inertia is present in every STE, even the ones with supportive leaders, however, STE directors with strong leadership capability are less worried about the inertia. Thus, we argue that the negative correlation does not reveal a real reduction of the behavioural inertia with an increase of leadership capability, but it highlights the different perceptions of directors about behavioural inertia importance according to their leadership. By contrast, directors

that did not disclose strong leadership tended to claim behavioural inertia as a reason to hold back transformation.

The results also mitigate findings from previous studies describing human capital as the key element for SMEs' digitalisation and performance (Charles O. Egbu 2004; Martin, Ciovica, and Cristescu 2013; Muda and Ridhuan Che Abdul Rahman 2016). The multiple case-study analysis did not indicate a strong difference between STEs who hired educated versus less-educated employees. The heavy workload constraining educated employees to focus on daily tasks was one cause of the waste of human capital for some STEs. Another cause was the general tendency to perceive organizational changes as being the responsibility of only the directors. These findings are in line with our quantitative results and the work of Ugalde-Binda et al. (2014), which did not show strong correlations between human capital and innovation performance. Researchers could focus less on best practices in human capital management for STEs because it will always be difficult for most STEs to adopt those practices. Management studies should rather look for more affordable – although perhaps less effective – practices to enhance STEs' innovation.

From a structural capital perspective, although some structural inertia was perceived among the 11 cases, the lack of correlation in the EFA model diminished its importance for STEs' digitalisation. The small size of STEs, their natural way of working in a team, and their low level of digitalisation should be considered as structural assets creating a favourable environment for any transformations. However, it would be worth to explore the impact of business process standardization on STEs' digitalisation. For instance, the director of the firm Pro participated in a governmental program to apply lean methods for waste reduction and standardization. Doing this exercise helped him to highlight the potential area of process digitalisation, which motivated him to start the digital journey.

Political inertia did not seem to affect the STEs' digitalisation; this finding was corroborated by the qualitative observation that STEs were not experiencing external pressure from clients or partners. However, qualitative observations also highlighted that STEs were isolated, without strong partners; this situation requires allocating time and resources to develop and maintain relational capital through professional associations or governmental programs. Unfortunately, it seemed a minority of STEs were allocating resources for enhancing their relational capability. It might be interesting to conduct further research on the reasons for this poor interest in developing relational capital.

The lack of correlation between a firm's performance and its level of digitalisation raised the question of the real value of digital transformation perceived by STE directors. We noticed, through a second review of the 11 interview transcripts, that all respondents had difficulty in quantifying the benefits of previous digital transformations. This might demonstrate either a lack of evidence about the benefits of digital solutions or a general belief that digitalisation is unimportant for the prosperity of STEs.

In conclusion, we provide a summary of the key organizational factors affecting STE' digitalisation. The lack of structural capital within STEs is particularly suited to the adoption of new web applications. From a human capital perspective, employees' behaviour is viewed as a barrier for STEs' digitalisation; however, the perception about the difficulty to overcome this barrier depends on the leadership capability developed by STE directors. Therefore, efforts should focus on improving the leadership and sensing capabilities of directors. Relational capital seems to support the increase of leadership and sensing capabilities. However, because of the scarcity of resources, STEs struggle to increase their relational capital. Among the 11 firms with an interest in digitalisation, only three took measures to develop their relational capital.

Overall, more initiative should focus on developing STEs relational capital and capability. However, caution is required about the methods applied to support STEs. Simpson and Docherty (2004) have highlighted the ongoing distrust among SME directors regarding failures about supportive events from government or external agencies. Reviewing the causes of these failures, they suggested focusing on mentoring and networking services; this point fits with our qualitative findings. However, we also wish to highlight the opportunity for academia to lead research on digital ecosystems that enhance relational and sensing capabilities. The only real barrier for STEs to initiate digital transformation seems to be managers' incorrect perceptions about the value and complexity of new digital practices. Therefore, a few questions merit attention. For example, what are the true and concrete benefits of digital transformation for STEs? Which kind of mentoring and network activities would effectively reduce behavioural inertia among STE directors?

This chapter proposes a methodology for developing a comprehensive overview of the relationships between intangible assets and intangible liabilities, in other words, dynamic capabilities and organizational inertias. Furthermore, it demonstrates the importance of mixed methodology in understanding the true nature of qualitative observations and quantitative correlations. For instance, structural

liability was relatively important in the qualitative study. However, the quantitative findings indicated that it was perhaps less important for STEs' digitalisation.

Researchers should note the assumptions made to explain the removal of the nine items and should view our decisions with some caution. Replications of the research, highlighting the context of STEs, might help to validate our rationale or develop a better explanation about the low factor loadings.

Overall, this chapter aimed to continue the work of Giuliani (2013) on the recognition of intellectual liabilities, in the intellectual capital literature. Our results also indicate the need to conduct field experiments to improve the management of STEs' relational capital. Indeed, this is necessary as intellectual capital research tends to be experimental studies focused on structural and human capital, whereas relational capital is less explored because of its more complex and heterogeneous nature (Martín-De-Castro et al. 2011).

Finally, this work supports Dumay's (2013) claims about the fourth stage of intellectual capital. That is, in the fourth stage, researchers should explore potential opportunities for developing sustainable environments to interconnect firms through intellectual capital management practices. We believe that academia should see the gap between available SaaS solutions and the current situation of most STEs as an opportunity to conduct management studies. We agree with Simpson and Docherty (2004) that support and advice for STEs should not necessarily be provided by experts. For instance, the potential of engineering students to perform business process analysis and live demonstrations of SaaS solutions for STEs has been validated through the test of the platform presented in Chapter 3. This platform might be considered a first attempt at creating a digital ecosystem, in which scholars might experiment with different knowledge management practices to enhance the sensing capabilities of STEs.

Chapter 5.

Contributions and Perspectives

A major issue for management studies is the relevance of research findings for practitioners (Rousseau 2006). Van de Ven (2007) argues that academic research in management tends not to be grounded enough in reality, which leads to the production of less relevant knowledge for practitioners. To help researchers avoid this, he provides guidelines to lead 'engaged scholarship. A short summary of the research findings under this lens of engaged scholarship is proposed to emphasise their relevance for academics and practitioners.

From an academic perspective, the value of using a digital platform connecting students and STEs to answer the first research question is discussed. As the research was limited to the assessment of collaborations with students, further potential research designs using other types of collaborations, methodologies, and technologies are proposed. Finally, from an STE perspective, the second research project highlighted the importance of relational, leadership, and sensing capabilities for the adoption of digital capabilities. Combining these observations with the results obtained from the action research, an overall methodology to enhance STEs' adoption is established.

5.1. An Engaged Scholarship

Van de Ven (2007, p. 34-35) defines four key points that researchers should follow to ensure a certain degree of engagement within any research:

1. Confront questions and anomalies arising in practices.
2. Organise the research project as a collaborative learning community of scholars and practitioners with diverse perspectives.
3. Conduct research that systematically examines not only alternative models and theories but alternative practical formulations of the question of interest.
4. Frame the research and its findings to contribute knowledge to academic disciplines, as well as one or more domains of practice.

The discussion below uses these four guidelines to present a short summary of the major findings of this thesis.

The research questions were initially established on previous findings made by practitioners and researchers. Practitioners such as consultancy firms and governmental agencies conducted surveys that revealed a generally low level of digitalisation for STEs. The academic literature highlighted three main reasons for this low level: 1) lack of knowledge, 2) lack of relative advantage perceived, and 3) lack of top management support. Currently, new web applications are usually easy to learn, and their features are basic (information sharing, tasks management, collaborative work), which reduces the level of knowledge necessary to use them. Furthermore, recent web applications use the business model freemium, which makes their relative advantage perceived by STEs stronger than complex digital solutions that would require contacting a consultant for a demonstration. Thus, action research and mixed-method research were designed to confront the anomaly that STEs are not starting digital transformation even though they could easily manage it.

The action research provided support, through the realisation of collaborative projects with students, to improve knowledge, perception, and leadership capabilities of STEs' top management. One characteristic that fits an engaged scholarship design was the attempt to create a collaborative learning community of students and STE directors. Collaborations were found valuable because of the strong intrinsic motivation of students that encouraged directors to raise their interest in new digital capabilities. Furthermore, many directors showed great expectations about students' work due to the university's reputation, which is well known amongst local businesses. From an overall perspective, the changes brought to the platform design demonstrate the great importance attached to students' and directors' needs. For instance, the major finding of this thesis about the possibility to publicly share project data on the platform was an idea developed during a group meeting with students. It was then validated by directors, which led to a reshaping of the platform design and research assumptions.

This shift in the platform design follows the third point about the necessity to examine alternative practical formulations of the question of interest. The first purpose of the research was to train digital and leadership capabilities through the realisation of collaborative projects between students and STEs' top managers. However, the feedback from the users of the first platform led to the decision to

completely re-examine the practical formulations of the platform's objective. Even though the objective of the second platform was less ambitious as it aimed to increase STEs' awareness instead of motivating them to adopt new digital solutions, it showed better pragmatic results. Furthermore, the mixed-method study not only examined alternative theories about key factors affecting STEs' adoption of digital platforms, but it also validated and generalised the findings of the first research by exploring the interdependence amongst key organisational factors. In other words, it looked for an alternative formulation of the main question about strengthening STEs' adoption, but instead of examining methods to enhance this, it clarified the barriers and enablers to improving the overall perspective of the situation.

The last of Van de Ven's (2007) four guidelines emphasise the importance of analysing contributions from both an academic and practitioner perspective. Distinguishing between these perspectives, however, is not an easy task within this research context because the digital platform was entirely managed by academics with the objective to create value for practitioners.

The first intention of the thesis was to expand knowledge about methods to enhance STEs' adoption of new digital practises. At that stage, the research frame was focussed on STEs' context, and a knowledge management experiment was designed to reduce barriers to digital transformation. Subsequently, the experiment design brought new perspectives about an additional contribution to the teaching domain by involving students on concrete projects, which offered an innovative field for soft skills training.

Furthermore, the mixed-method study also contributed to both realms. From an academic perspective, it explored the organisational factors affecting STEs' adoption of digital transformation. From a practitioner perspective, the survey acted as a benchmarking tool to increase STEs' awareness of digital opportunities. After having filled out the survey, a small consultancy firm and a Swiss chamber of commerce asked for additional information on the survey design with an interest in duplicating it for their clients or members. Therefore, the design used for this thesis suits engaged scholarship and demonstrates high potential and value for academia and practitioners.

5.2. Contribution to the literature on SMEs

A research question of this thesis was:

What are the organizational factors affecting STEs' digitalisation?

It came from a need to deepen our understanding of the true causes of the slow adoption of digital practices by STEs. The action research showed that the perception and knowledge of STE directors can be improved through live demonstrations of digital solutions done by students. However, no real improvements were observed about changes in the leadership capability of the STE directors. These observations suggest that the lack of knowledge and the lack of relative advantage perceived can be managed through collaborations with motivated people who are skilled, but not necessarily experts, in digital solutions (Simpson and Docherty 2004). However, improving leadership capabilities is a key factor that requires another type of support.

Thus, mixed-methods research was designed to contribute to the literature on organisational factors affecting STEs' digitalisation. This method tested an innovative conceptual framework that combined three organisational theories: dynamic capabilities, intellectual capital, and organisational inertia. The decision to develop this framework came from the observation that most of the previous studies primarily used technology-oriented models or grounded classification. These studies highlighted top management support as one of the key factors. However, they did not explore the antecedents or the relationships with other factors that could have an effect on the STEs' leadership capability. This gap justified the need to develop the conceptual framework used, which was tested with eleven semi-structured interviews. The qualitative results suggest that leadership and sensing capabilities are more important than absorptive or integrative capabilities. Furthermore, a certain degree of psychological, cultural, and structural inertia was observed amongst different case studies.

To validate and enhance comprehension about the different weights of these organisational dimensions, an exploratory factors analysis was performed on a dataset of 211 STEs. The quantitative results revealed a positive correlation between STEs' digitalisation and the two dynamic capabilities: sensing and leadership. Furthermore, a positive correlation between relational, leadership, and sensing capabilities was found. Combining these quantitative results with the qualitative observations, it

appears that STE directors who have developed their relational capability had better sensing and leadership capabilities. This finding is in line with previous studies about the importance of initiatives to increase mentoring and networking activities within STEs (Fichter 2009; Lee et al. 2010; Lin et al. 2016; Rothwell 1991).

Another contribution to the literature was the assessment of potential organisational inertia hindering STEs' digitalisation. The cross-case synthesis highlighted a certain level of cultural and psychological inertia in more than half of the cases. Such inertia was also observed in the exploratory factor analysis under the general factor of behavioural inertia. A contribution of this research was to propose an explanation of the negative correlation observed between leadership capability and behavioural inertia factors. From the qualitative observations, it appears that the level of behavioural inertia perceived by directors is moderated by the strength of their leadership capability. In other words, directors with a long-term vision about digital transformation will perceive employee resistance as an obstacle to be managed, whilst other directors will consider it as a sufficient reason to wait until the transformation occurs naturally with the arrival of new employees. However, these findings merit further research to increase their validity.

One important limitation of this research was its exploratory approach, which can weaken the validity of the findings. Further studies must confirm the relationship between STEs' organisational factors. One suggestion is a survey using the construct obtained through the exploratory factor analysis. The data should be analysed through a confirmatory factor analysis to validate the model. Statistical tests could later be run to validate the hypotheses about the positive and negative correlations amongst relational, leadership, and sensing capabilities, behavioural inertia, and the level of STEs' digitalisation. Semi-structured interviews can also be conducted to define plausible explanations for the different correlations observed. Thus, a confirmatory study can perform a cross-case synthesis after the survey, which is the opposite of the exploratory methodology used in this thesis.

5.3. Contribution to the literature on Open Innovation

The action research introduced a concept of an open innovation platform that has, to the best of my knowledge, never before been explored in the literature. Open innovation involving the collaboration between SMEs and universities was previously focussed on product or service innovation (Brunswicker and Vanhaverbeke 2015; Hossain and Kauranen 2016). Furthermore, open innovation strategies are usually adopted by medium firms that have the necessary resources, whilst STEs remain focussed on running their core operations (Van De Vrande, Jong, and Vanhaverbeke 2009). For STEs to embark in open innovation initiatives, the role of an intermediary is crucial (Lee et al. 2010).

Another element observed in previous studies was the lack of engagement from STEs because of the distinction between academic research and STEs' expectations (Wynarczyk, Piperopoulos, and McAdam 2013). The increase of SaaS solutions on the Internet is a real opportunity for STEs to easily adopt new digital practises. However, their lack of resources and weak awareness about these opportunities slows down their adoption rates. From these observations, the concept was developed of an open innovation platform offering STEs the opportunity to collaborate with students on the assessment of these digital solutions for their business processes. This concept generated a secondary research question:

What is the value for academia and STEs to collaborate on projects about digital transformation through a digital platform?

Of the thirty-nine collaborative projects conducted on the platform, sixteen were considered by STEs participants as a valuable experience, and ten produced small transformations, which is considered as a success. In other words, 67% of the STE participants acknowledged the value of this open innovation initiative. It is important to note that the important sample size reduced the potential risk of misjudging the participants' perception of value. Furthermore, half of the thirty-four students involved showed a strong intrinsic motivation to lead their projects, which emphasised the value not only for STEs but also for those in academia to lead such an initiative.

Therefore, this research demonstrated the value of an open innovation platform for process innovation of STEs, which is different from platforms for product or service innovation. For instance, such platforms require attracting experts with the

right skills to progress into the innovation process. They must also manage confidentiality and a rewards system to ensure the competitive value of an innovation developed on the platform. On the contrary, the results obtained from the platform tested in Chapter 3 showed that experts are not necessarily needed to trigger digital transformations within STEs. The support of a student with a strong intrinsic motivation and a certain affinity with new digital practises can be sufficient. Furthermore, the only potential issue about confidentiality is to maintain the STEs' anonymity. Otherwise, the project data could be publicly disclosed on the platform. From a more general perspective, this research should motivate researchers to explore other open innovation concepts.

To illustrate this recommendation with an example, another platform was developed by a start-up called Alaya (Corset 2018). It aimed to connect employees of large firms to small non-governmental organisations (NGOs) from developing countries. Their platform offers an easy way for an employee to offer his or her professional skills for free to NGOs. Many work tasks today can be done remotely, such as accounting, web design, marketing, project management, and so on. Thus, Alaya connects people with such skills to small NGOs to help them to grow. With the support of top management, employees are volunteering during working hours. This combination has great value for the stakeholders. It is a way to improve workplace well-being by letting employees do useful work for a humanitarian cause. It also improves the firm's reputation and helps small NGOs that do not have the level of expertise or the resources of large firms. In a certain way, many similarities can be drawn between this example and the platform used in this study.

5.4. Perspectives for Knowledge Management experiments

The contributions to the literature on SMEs and open innovation also suggest perspectives for further research on knowledge management within STEs. For instance, leadership capability seems to be the main enabler or hindrance for STEs' digitalisation. However, to the best of my knowledge, there are no concrete results demonstrating efficient methods to develop the right leadership capabilities in STE directors.

The platform presented in this thesis should be considered within academia as a prototype to build a new digital environment to lead further research in the context

of STEs. Table 35 sums up the main findings observed during the test of the platform and raises some questions that might lead to further research.

Table 35: Main findings of the action research

1st platform	2nd platform	Conclusion	Future research
Students			
Students struggled to lead a project without proper directives to follow	Students liked the opportunity to perform real interviews	Students have a strong motivation to develop their soft skills	How could we monitor and train students' soft skills?
STEs			
Participants were not motivated to perform deep analyses of their processes.	Participants agreed to publicly share the models and solutions developed.	Participants were only interested in increasing their awareness of new digital solutions.	What is the potential to scale the platform concept?
Methods			
A flexible BPMN tool combined with an agile approach was confusing for students.	Defining a simple model to apply for each phase of a structured project plan empowered students.	Model templates are efficient to support students with appropriate knowledge at the right time.	How could we assess the efficiency of management models and methods?
Technologies			
STEs were not motivated to learn and use the modelling application to produce knowledge	Phone calls with a screen-sharing app were efficient for interviews and live demonstrations.	The platform features should focus on empowering students' acquisition of new knowledge	What is the potential of machine learning to support students?

The importance of developing strong soft skills such as communication and collaboration have been well recognised by students (Ait et al. 2015), which has also been observed through their strong motivation to participate in the action research. Thus, this suggests the importance of leading similar research on the innovation of teaching practises on soft skills development. From a student perspective, replicating

the digital platform could offer new teaching practises to train students in soft skills. For instance, a similar platform could be integrated into a course on digital transformation or project management, leading teams of students to work on the same projects. Instead of applying business cases, students might apply management models in real cases. However, the question remains about the real impact of such small collaborative projects on the development of students' soft skills. Thus, researchers should explore methods to assess the soft skills developed during the projects. For instance, teachers might ask students to record their interviews. Then a peer review by other students might help to improve students' communication skills.

The thesis found evidence of the potential that further similar initiatives could have on society. In an age when organisational boundaries are reshaped with new technologies, academia should increase research on digital communities to support STEs. Until now, one plausible reason for this lack of interest was the difficulty for academia to perceive the context of STEs as a suitable field for management studies. However, due to the poor resources and interest from STEs about management studies, the situation may not change without the support of an outsider to create a favourable environment for leading research (Jasieński, Candi, and Rzeźnik 2015). Thus, instead of waiting for initiatives from governmental agencies or other associations, academia has all the resources necessary to develop knowledge management experiments to truly support STEs and provide reliable data for research.

From a pragmatic perspective, there are fifty thousand small firms with between ten and fifty employees in Switzerland. This number explains the struggles of small governmental agencies to provide adequate support for each of these enterprises. As an example, most of the participants were grateful to be included because they were unable to find similar initiatives before the ones in which they participated. The fact that the platform gave them an easy way to submit a project and to see what others have done was a key element in their decision to participate. However, a question remains about the long-term viability of the platform. Crossing the chasm is a major concern for almost every start-up that aims to evolve its products or services from early adopters to mainstream customers. The same concern is applied to this research. The STEs observed during this study must be considered early adopters. However, further research should assess the potential to scale the platform concept to a wider population of STEs.

One other major value of this research was the design of a methodology to empower students about leading projects for STEs. It was composed of different

methods and models such as BPM, the value proposition canvas, the results pyramid, and the absorptive capacity model. Their objective was to help the students develop the right knowledge during the different project phases. The feedback from students pointed to the value proposition canvas and BPM as the most useful tools, whilst they had mixed feelings about the results pyramid and failed to grasp the value of the absorptive capacity model. The idea behind the use of the results pyramid and absorptive capacity model was to train students and STE directors to analyse a firm's situation and develop the appropriate leadership capability to lead a transformation. However, the lack of involvement from directors and the small number of interviews made it difficult for students to develop enough knowledge about the firm's situation to apply these models. The platform was designed to let researchers easily change the methodology applied during projects. As the methodology proposed in this thesis was composed of models, tools, and methods found through personal research, it would be insightful to lead further research on the application of other management models.

This thesis also demonstrated the potential of a digital platform to gather enough data in a short period of time to produce valuable case studies that might be reused as the foundations for mixed-method research. For instance, if a university decided to scale the platform to a class of one hundred students, it could produce twenty projects per semester with teams of five students working on a project. This number of projects could be supervised by a professor as the second platform showed great results about empowering students to lead projects with minimal support required from a supervisor. Thus, in a period of three years, the platform might gather more than one hundred case studies, which makes a solid database for further research.

From a technological perspective, the digital platform did not make great progress in the creation of new technology to enhance STEs' adoption of new digital practises. However, the demonstration of the viability of leading a research project using a digital platform connecting students and STEs created a favourable environment for collecting data that might be used for leading research on new technologies such as machine learning. For instance, the interviews conducted by the students could be recorded and automatically transcribed. The transcripts and models could then be analysed with a natural language processing program to allow the comparison of keywords amongst the projects. Finally, a machine learning algorithm might assess the quality of the interviews and models and propose solutions.

Whilst this thesis makes important contributions to academia, it also demonstrated the need, value, and opportunity of leading experimental research on fields such as soft skills training, community of practices, STEs' leadership capability, and machine learning. The value added by this thesis to the field of academia can be summarised with a quote from Burke (2010) in his paper discussing the research-teaching gap in management: "We believe a tighter link between research and teaching is critical to enhancing student learning about the value of research and to giving them—our future managers—the skills they will need to be lifelong consumers of management research."

Lastly, researchers should consider the platform an opportunity to train students to apply management models on real cases, which should improve the students' perception about the value of their learning and increase their willingness, as future managers, to stay updated on research findings in management.

5.5. A Framework to enhance STEs' Digitalisation

This thesis did not attempt to figure out the best practises that STEs should apply to lead successful digital transformations. Instead of defining a list of the key enablers for STEs' digital transformation, researchers should consider the feasibility and the relative importance of developing these enablers for STEs. For instance, previous studies have highlighted the importance of increasing human capital through training and hiring skilled employees to foster digital transformation within STEs (Martin et al. 2013; Muda and Ridhuan Che Abdul Rahman 2016). Based on the observations from the projects and case studies, most of the STE directors either do not have enough resources to properly develop their human capital, or they prefer to look for external support to increase their digital awareness. Along this line, the main research question of this thesis was:

How STEs' digitalisation phenomenon could be efficiently enhanced?

Using findings from the two studies presented in the thesis, a framework was proposed that could be followed by a majority of STEs. This framework focusses on the improvement of the sensing and leadership capabilities through the development of STEs' relational capability.

5.5.1. Sensing capability

A critical characteristic of STEs observed during the two studies (see Chapters 3 and 4) was their isolation. This characteristic was the main cause for the lack of knowledge and the weak relative advantage perceived for the new digital capabilities. The results obtained with the projects performed on the platform NousInnovons.ch showed that several exchanges with students were enough to create a sensing capability strong enough to trigger changes. Thus, STEs should look for opportunities to exchange information about new digital practises to maintain a minimal level of sensing capability. Because most STEs have limited resources, the recruitment of a student during a short period for the research of business process innovation is probably one of the best low-cost solutions that almost every STE could afford it. If STEs cannot find an initiative similar to the NousInnovons.ch platform, other ways of recruiting a student should also be tested, such as proposing internships or hiring for a part-time job.

Academia or governmental agencies might act as facilitators in the recruitment process of students. Furthermore, other small collaborations might also be established with people from informal networks or internally from the firm. The key element is the recruitment of a digital advisor with a strong motivation to look for optimisation and an affinity for digital solutions. The results obtained with the projects showed that a workload of half a day per week is enough for the digital advisor to develop knowledge about potential opportunities for digital transformations. Directors can allocate at least one hour per week to perform live demonstrations of the solutions with the digital advisor. It is essential to maintain a certain path during this exploratory phase; otherwise, the digital advisor and director will lose their motivation, and the initiative will stop before barely even starting. It is also crucial to focus on a small project with benefits that are easy to perceive. More complex projects will have a high chance of leading the digital advisor into a stalemate because he or she may not find any ready-made solutions on the Internet. These digital solutions should be easily tested to increase the relative advantage perceived by directors and colleagues. It is crucial to demonstrate the value of SaaS solutions with ‘quick wins’ before looking for bigger organisational changes. As a starting point in the research journey of the digital advisors, a short selection of digital solutions tested by students or proposed by STEs in chapters 3 and 4 is presented in Table 36.

Table 36: Propositions of digital solutions to be tested

Name	Description
Workforce engagement	
Airtable	Spreadsheet with nice features to improve collaboration
Slack	Messenger app with strong integrations to other systems
Appsheet	Platform to create small apps
Trello	Collaborative task management
Wrike	Project management applications with multiple levels of analysis, user access management features, etc…
Wimi Teamwork	
Basecamp	
Customer relationship	
Typeform	Create nice surveys to improve customer engagement
Event Temple	Venue Management Software
Insightly	CRM solutions with multiple features such as digital marketing, ticket management, integration to e-commerce platforms, combination with ERP features, etc…
Dynamics 365	
Hubspot	
Salesforce	
Sugar CRM	
Zoho	
Operational processes	
KissFlow	Application to set up automated workflows (easy to use)
M-Files	Intelligent information management
Odoo	ERP solutions with features as process automation, financial analysis, inventory management, CRM integration, etc…
Triviso	
Solvaxis Pro-concept	
Current RMS	Rental management software with strong inventory features
Calamari	Leave management and tracking attendance
Absence.io	
Bexio	Accounting solutions with features as invoices automation, integration with banking systems, creation of proposals, etc…
Cresus	
WinBiz	

5.5.2. Leadership capability

Findings from the mixed-methods study revealed that leadership capability is more important than absorptive or integrative capabilities in the STEs' adoption of new digital practices. The leadership capability factor included items related to the long-term vision developed by STE directors. Reviewing the directors' characteristics in the case studies, two strategies were applied by STEs to develop their leadership capability. First, several STEs had recruited young directors with an intrinsic strong motivation to improve their firms. Their motivation was enough to trigger changes within the firm even if a long-term vision was not clearly established. General feedback from well-established directors revealed that they were more focused on managing their firms than looking for an opportunity to improve it. Of the few directors who showed a certain degree of engagement through the establishment of a long-term vision, a majority also participated in professional networking events or governmental programs. Thus, it appears that STE directors are motivated by peers to enhance their leadership capability. It also seems that from an STE's perspective, developing the right leadership capability means increasing the director's confidence in his or her capacity to lead a transformation.

To illustrate the importance of STE directors developing their long-term vision about digital transformation, a story by Ancona (2011) demonstrates the impact of sensemaking for the leader and the key role of mapping a long-term vision:

> A small military unit was sent on a training mission in the Swiss Alps. They did not know the terrain very well, and suddenly it began to snow. It snowed for two days. There were large drifts everywhere, and it was hard to see through the clouds and blowing snow. The men considered themselves lost. They were cold and hungry, and panic began to spread through the unit as they thought of what would become of them. But then one of them found a map in his pocket. Everyone crowded around trying to figure out where they were and how they could get out. They calmed down, located themselves, and plotted a route back to their base. They pitched camp, lasted out the snowstorm, and moved into action. Of course, they didn't always hit the landmarks they thought they would, so getting back involved still more sensemaking. They got help from villagers along the way and shifted their path when faced with obstacles. And

then, when they finally got back to base camp, they discovered that the map they had been using was actually a map of the Pyrenees and not the Alps.

To draw a parallel with the content of this thesis, the main barrier for STEs' digitalisation is the difficulty for a director to create a mental map of the digital journey. There are models or methods developed by consultancy firms to assess the digital maturity of a firm and to develop maps for leading transformation (Uhl and Gollenia 2015; Westerman, Didier Bonnet, et al. 2014). However, two factors make the use of these approaches by STE directors highly improbable. First, the models proposed usually analyse many characteristics to help large firms' directors develop the appropriate governance for organisational and structural changes. However, as shown by the results of the mixed-methods study, STEs' main issue is not the management of structural or organisational changes; it is instead related to the development of adequate leadership and sensing capabilities. Thus, the issue is not about defining accurate methods or plans for leading successful digital transformation but to increase their confidence to start the process.

Previous literature has highlighted the potential value of directors acting as mentors for other directors to activate transformational leadership and promote positive work attitudes (Mavrinac 2005; Scandura and Williams 2004; Solansky 2010). Using the potential brought by the platform to gather STE directors in one place, a community manager could select the most motivated participants to create a team of directors from different STEs. This team could apply co-mentoring activities about leadership capability to establish a long-term program.

Finally, it is important to clarify the different types of practitioners who might be involved in the enhancement of STEs' digitalisation. This research restricted the use of the platform to students and STEs. However, the platform might also raise the interest of other practitioners such as consultants or governmental agencies. The consultants might act as community experts to help STEs overcome obstacles, and the governmental agencies might act as community managers supervising the mentoring programmes.

A conceptual framework of a community of practices following a process involving academia, government, and experts is shown in Figure 29. This framework aims to improve the sensing and leadership capabilities of STEs.

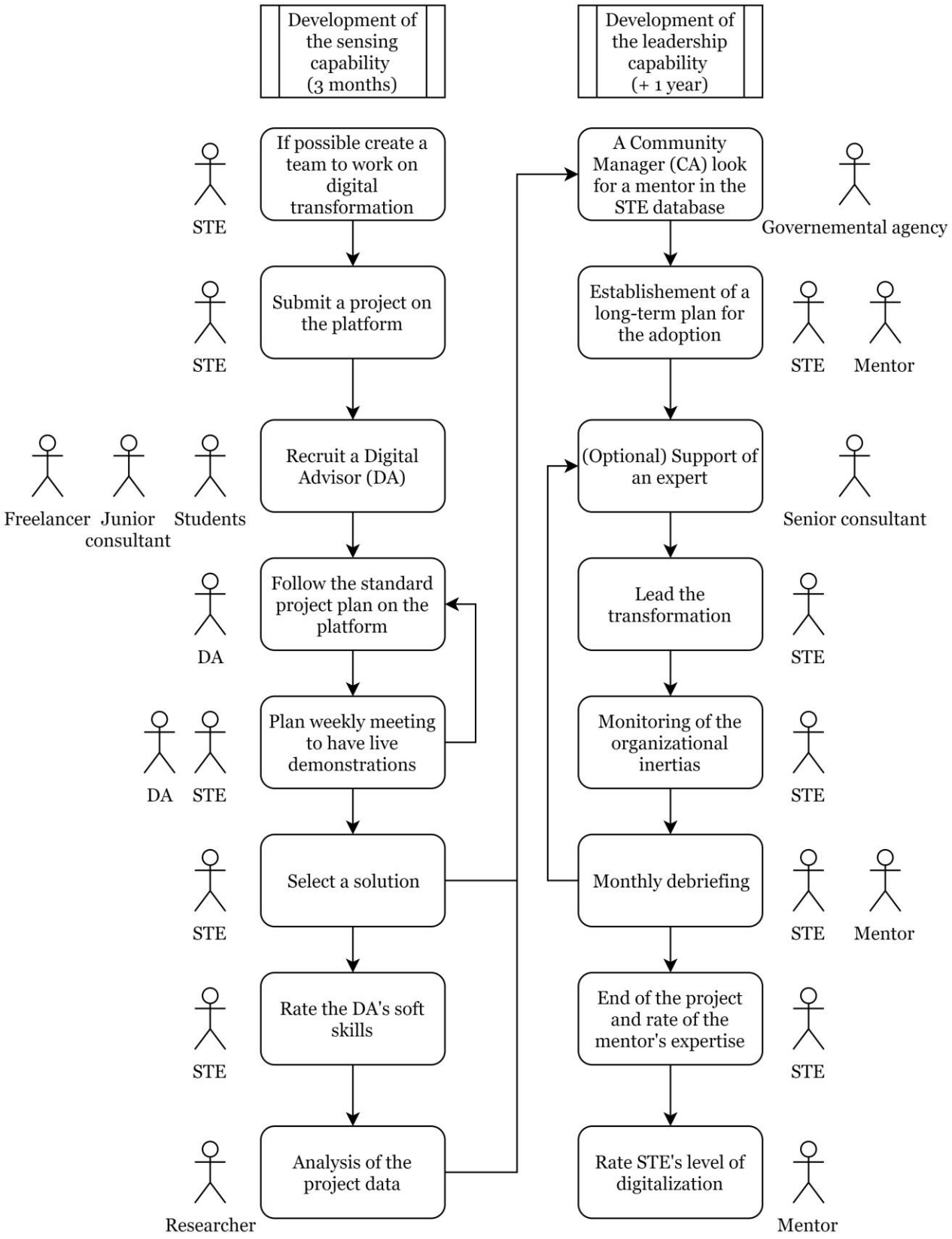


Figure 29: Framework of a community of practices to improve leadership and sensing capabilities of STEs

The major difference between this framework and the platform tested in this thesis is the former's structure, which will allow external actors such as governmental agencies and consultants to complete the digital community. As the platform is not restricted to students from one university, its potential to scale is enhanced. (However, new concerns about compensation for students' work should be established.)

The first phase of the framework uses the same concept of connecting STEs to digital advisors (students) to lead three-month projects for the research of digital transformation opportunities. However, the possibility to recruit external people such as junior consultants or freelancers will allow STEs with complex projects to find adequate support. A selection criterion between students and junior consultants will probably be the fees asked for digital advising.

Once an STE director has defined a solution to adopt, a community manager might set up mentoring activities between him or her and another director who has successfully managed the adoption of a similar solution. The role of the community manager should fit with governmental agencies that have strong ties with STE directors. However, a question remains about the value of STE mentors' participation. As a suggestion, a motivation for mentors could be to acquire a public reputation on the platform to show the mentor's strong level of expertise and humanitarian values, which could add value to his or her enterprise. In a similar way, the recognition of soft skills is a major concern for most students, junior consultants, or freelancers. Thus, gamification features such as level of expertise in advising, analysing, mentoring, or other soft skills could be added to the platform to offer public recognition to students.

Finally, this framework is a proposition for setting up new research that would allow the analysis of a complex community of practices, which would provide an opportunity for researchers to gather data from many perspectives. However, it would also require more resources to manage, and each actor's role should be discussed before starting the experiment.

5.6 Conclusion

In this age of major innovation, academia should conduct more field experiments to examine the opportunities to innovate in teaching, instead of focusing on analysing innovations for the business world. An initial digital transformation of academia has started, with the appearance of massive open online courses (MOOCs). A natural evolution of such courses would be the creation of collaborative platforms to allow students to work on real cases. Thus, the digital platform presented in this thesis should inspire academia to explore this opportunity of innovating teaching methods.

Furthermore, STEs have been neglected in the literature. However, STEs constitute a vital part of the economy of every country and research in this field should not be avoided. This is especially true with the democratisation of ICT, which is a major disruption for everyone. A contribution of the thesis was to demonstrate a viable way of leading research in this field using a digital platform.

An unexpected finding was the possibility to publicly share results of business process analyses of STEs on the digital platform. Unlike large firms, which request a high level of confidentiality, STEs merely want to hide their identity. The possibility to share project results on a platform is relatively rare and allows the application of open innovation strategies. Thus, the action research offers new perspectives for the open innovation literature, which should motivate researchers to explore this field. A framework of the platform structure was provided, with a link to an open-source repository, to facilitate its duplication at the end of Chapter 3 (Cavillier 2018).

For practitioners, the action research provided some contributions to STEs' managers and consultants. The platform was designed to facilitate collaboration between students and STEs. A methodology for leading small digital transformation processes have been developed and tested over five iterative loops. However, this methodology could easily be extended to other type of collaborations. The platform might be open to anyone to develop an online community of practices. Anyone would be able to start a digital transformation project following this methodology and might require support from peers, experts or consultants when needed. It might be an interesting alternative to classical consultancy services because of the collaborative experiences, with comparison among projects.

Furthermore, the possibility to easily duplicate the platform might motivate practitioners to use it as a prototype to foster knowledge management experiments in other contexts. For instance, governmental agencies in developing countries could duplicate their own platform to create a knowledge centre helping small local firms to increase their awareness about new digital practices. The duplication of the full concept in developing countries might have even more impact because of the bigger challenge about resources and knowledge management supporting the development of small local businesses.

Another potential application could be the integration of this platform within large enterprises. The importance of knowledge management is becoming a main concern for top management. However, knowledge management systems developed and used by large firms are usually documentation systems supporting employees to retrieve faster information. The platform presented in this thesis proposes a methodology that showed great results to co-create knowledge. Thus, this methodology might also have great value for larger enterprises. For instance, top management could duplicate the platform and use it to involve employees in the design of requirements for a new digital solution such as an ERP or CRM. Providing an easy way to collect but also interact and co-create knowledge with future users of a solution should improve the transformation phase. Thus, the value of this platform should not only be reduced to the improvement of academia- STEs collaboration, but practitioners should also consider its application into other fields.

To explore what should be the key organizational factors that the community of practices should focus on to foster STEs' digitalisation, a mixed-methods research study was conducted. A framework was created to look at intangible assets but also intangible liabilities that affect the adoption of new digital practices within STEs. Studies related to these theories have usually focused on intangible assets, which have a beneficial effect on a firm's performance, whereas intangible liabilities have been neglected. Thus, the conceptual framework portrays not only the enablers but also the inhibitors of STE digital transformation. This allows analysing a firm's situation with a more global perspective than previous frameworks in the literature.

The qualitative observations and quantitative data showed that STEs with a low level of digitalisation usually had relatively weak leadership capabilities and relatively strong behavioural inertia, such as employees' resistance. The observations from the multiple case-study analysis were used to clarify these correlations. They emphasized that, contrary to the quantitative data, almost all the cases showed the

same level of behavioural inertia, independently of leadership capabilities. The confidence of directors in their leadership and digital capabilities was the key factor that changed their perception about the behavioural inertia within their firms. In other words, directors who were confident were also aware of the behavioural resistance from their employees, but they were not particularly worried about it. Furthermore, it appeared that relational capability was important to foster the right leadership capability for digital transformation. Therefore, this study indicates the need to focus on developing the relational capability to support the leadership of STE directors, without necessarily improving other organizational factors. This is supporting the value of a community of practices fostering networking and mentoring activity.

The action research and mixed-method research bring clarity about the possibilities for STEs to increase their readiness to adopt new digital practices. A global observation is that findings from previous literature about the need to enhance the training and education of SMEs' human capital are not appropriate to the STE context. STEs do not have the time and resources to train or hire employees with appropriate skills to lead digital transformations. Furthermore, digital transformation is not their priority; they focus on actions with quick returns on investments.

However, new technologies make it easier to start a digital transformation even without previous skills in this domain. Thus, STEs have the possibility to start small transformations, which can increase their awareness about other digital opportunities. A key element for motivating STEs directors to consider digital solutions is a social activity, which allows exchanging informal knowledge with peers or other actors such as students. This element was highlighted by the two studies.

As a final quote to sum up the study's beliefs about the true value of students collaborating with STEs, Antoine de Saint-Exupery stated, "If you want to build a ship, don't drum up people to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea."

In other words, this research made a first step in training students and STEs to not simply analyse business processes but to long for the endless immensity of the digital transformation journey.

Appendices

1. Project proposal of the 1st platform sent to STEs

Résumé

Dans le cadre de sa recherche doctorale, l'étudiant Quentin Cavillier cherche à développer une communauté regroupant étudiants EPFL et organisations autours d'un seul objectif : **Le renforcement de la capacité d'adoption et d'innovation des PMEs face aux nouvelles technologies.**

Suivant cette idée, le développement d'une plateforme internet (https://ite.coach) a été décidé afin d'offrir un environnement collaboratif aux étudiants et organisations. Ses objectifs étant de rassembler, évaluer et conserver toutes les idées et résultats produits lors de travaux de groupes entre étudiants et collaborateurs.

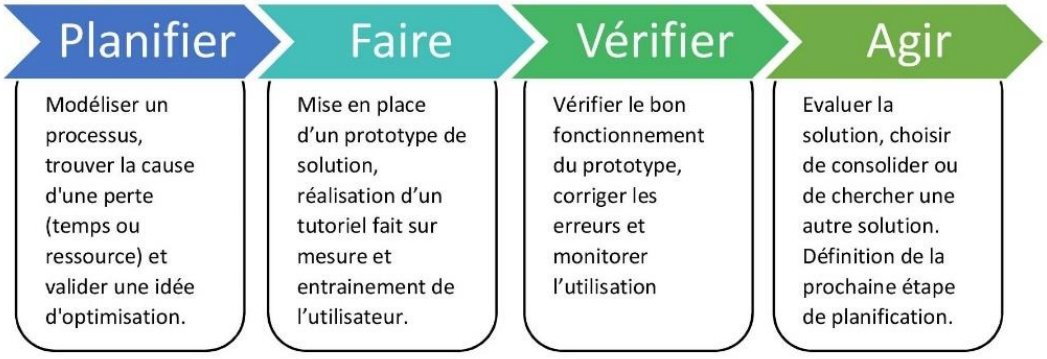
Proposition

La chair de Logistique, Économique et Management de l'EPFL s'engage à fournir un support de 2 heures par semaine par nombre de participants. Ce support sera fourni par un étudiant de Master réalisant un projet de semestre. Il sera fourni exclusivement au travers de la plateforme et à distance. Les tâches de l'étudiant seront l'analyse et la modélisation de processus organisationnels de l'entreprise, la recherche et proposition d'optimisations de ces derniers, et l'encadrement dans l'apprentissage, la mise en œuvre et l'évaluation des solutions. Toutes les données récoltées resteront confidentielles et uniquement des observations générales et anonymisées seront utilisées dans le cadre de la recherche.

L'entreprise s'engage à participer à la recherche sur une durée de 4 mois, de Mars 2017 à Juin 2017. Le nombre de participants étant à définir avant le début de la recherche, cela en fonction des ressources disponibles de l'entreprise et de la recherche. Chaque participant devra allouer 45 minutes de son temps de travail par semaine afin de participer à un travail de groupe une semaine sur deux et travailler sur les propositions de l'étudiant les deuxièmes semaines.

La méthodologie utilisée durant ces quatre mois suivra le cercle « Planifier, Faire, Vérifier, et Agir », voir figure ci-dessous. Chaque phase sera réalisée sur une période de deux semaines. En quatre mois, chaque participant aura donc la possibilité de réalisés deux itérations du cercle et ainsi de tester deux idées d'optimisations.

La finalité de la participation sera d'évaluer quel est l'impact sur une PME que 45 minutes de travail par semaine dédié à la recherche, compréhension et test d'idées peut produire.



2. Project plan of the 2nd platform shared with students and STEs

1 Introduction

Ce plan décrit les grandes étapes et règles à suivre pour la réalisation d'un projet sur la plate-forme NousInnovons.ch. En soumettant un projet comme entreprise ou en vous enregistrant pour un projet comme étudiant, vous vous engagez à suivre ce plan. Pour résumer, l'entreprise s'engage à allouer un responsable pour la réalisation de vidéo-conférences de 30 minutes par semaine pendant deux mois. L'entreprise s'engage aussi à partager une liste d'emails d'au minimum huit collaborateurs afin que l'étudiant puisse leur envoyer une présentation vidéo et PDF de sa solution et obtenir des retours. L'étudiant s'engage à travailler sur le projet six heures par semaine pendant trois mois. Un accord de confidentialité sera signé en annexe de ce plan par l'étudiant. Comme l'étudiant réalise cette étude dans le cadre d'une recherche doctorale, la participation est gratuite pour l'entreprise. Cependant, les modèles et analyses seront anonymisés et utilisés comme données dans des publications liées à la recherche.

Le projet débutera début Octobre pour une durée de 3 mois. Un plan résumant les douze semaines est proposé à la page suivante. La moitié du projet sera dédié à l'application de cinq modèles afin d'aider l'étudiant dans sa compréhension de la situation actuelle de l'entreprise. L'autre moitié du projet sera dédié à des présentations et évaluations de solutions par l'entreprise. Celles-ci se feront lors de démonstrations réalisées par l'étudiant au travers de partage d'écrans. A la fin du projet, l'entreprise recevra : 1) un rapport décrivant le processus à améliorer au travers des cinq modèles, 2) un résumé d'une potentielle solution retenue par l'entreprise avec en annexe un tutoriel de prise en main de cette dernière.

Entreprise

Date : Nom : Signature :

Etudiant

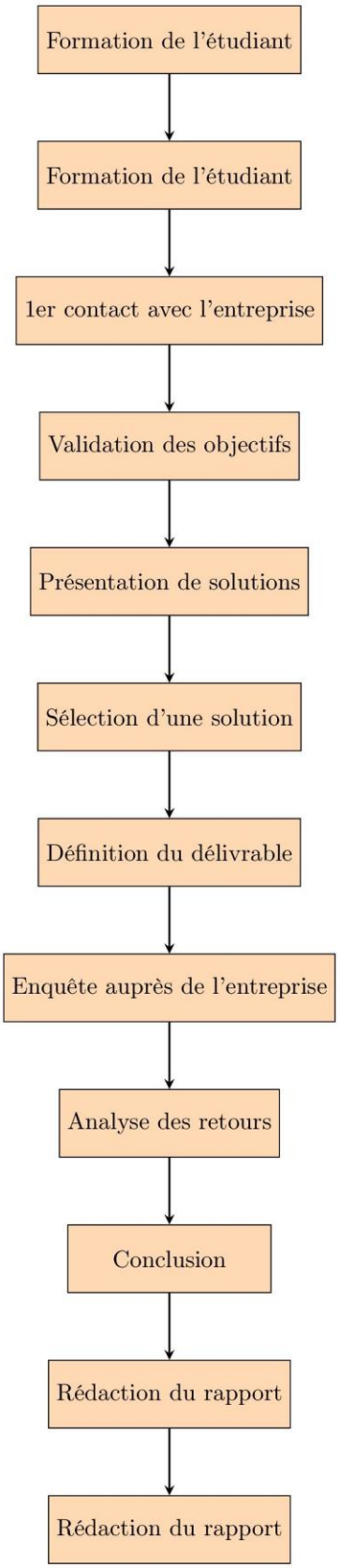
Date : Nom : Signature :

Superviseur

Date : Nom : Signature :

03.09.2018 Quentin Cavillier

2 Vue globale des 12 semaines du projet



Semaine 1) (mi-Septembre 2018) Attribution du projet à un étudiant

2) Test d'anciennes solutions par l'étudiant

3) 1ère vidéo-conférence (v-c) début Octobre : Présentation de la situation actuelle

4) 2ème v-c : Discussion et validation des modèles "Situation" et "Sélection".

5) 3ème v-c : Présentation de solutions au travers d'un partage d'écrans

6) 4ème v-c : Approfondissement et sélection d'une solution au travers d'un partage d'écrans

7) 5ème v-c : Établissement de la structure du délivrable et modélisation du modèle "Prototype" .

8) 6ème v-c : Validation de la vidéo et/ou PDF d'introduction de la solution à envoyer aux collaborateurs.

9) 7ème v-c : Discussion des retours obtenus et réalisation du modèle "Stratégie"

10) 8ème v-c (fin Novembre) : Dernière rencontre et tour de table des risques et barrières avec le modèle "Conclusion"

3 Plan détaillé du projet

Semaine 1 Recherche de potentielles solutions

I Objectifs de l'étudiant

1. Envoyer un email de présentation et fixer un rendez-vous pour la 3ème semaine (dans 2 semaines),
2. (4h) Faire une liste de 9 solutions potentielles. Pour cela, il vous faut parcourir internet, aller sur des "annuaires" d'applications comme Zappier.com or Getapp.com. Puis, pour les sélectionner, il faut voir leurs vidéos de présentations et déjà vous imaginer comment l'entreprise pourrait les utiliser. Faire un tableau comparatif dans le document de l'évaluation continue. Publier le tableau en PDF sur NousInnovons.ch dans la partie "Progrès" sous semaine 1. Cette liste ne doit pas être transmis à l'entreprise et est uniquement un moyen d'évaluation pour le superviseur de s'assurer que l'étudiant cherche des solutions dans la "bonne direction". Les solutions retenues doivent pouvoir être testées (soit une période d'essai soit en mode "free").

II Objectifs de l'entreprise

1. Fixer un rendez-vous pour dans 2 semaines.

Semaine 2 Test des applications

I Objectifs de l'étudiant

1. (4h) Sélectionner 5 applications parmi les 9 et commencer à les tester. Les tester correspond à se créer un compte et appliquer des "scénarios" test pour réellement évaluer les différentes fonctions de ces applications. Faire un tableau de comparaison entre les 6 solutions dans le document "Évaluation continue".
2. Relancer l'entreprise assez tôt dans le début de la semaine si le rendez-vous n'a toujours pas été fixé.

II Objectifs de l'entreprise

1. Fixer un rendez-vous pour la semaine prochaine si besoin.

Semaine 3 1ère vidéo-conférence (v-c), validation du modèle "Situation"

I Objectifs de l'étudiant

1. (2h) Tester les solutions restantes.
2. (1h) Préparer l'interview en réalisant une ébauche du modèle "Situation". L'objectif de l'interview est de réaliser une première version de la modélisation du processus que l'on cherche à améliorer dans ce projet. Ce modèle se construit en fonction de votre intuition. Il sera utile pour, dès le début de l'interview, amener le participant de l'entreprise à échanger avec vous sur sa façon de travailler. Ainsi vous pouvez vous posez à vous même les questions suivantes afin d'essayer de modéliser un processus :
   (a) Quel est le processus ciblé ? Quelle est sa valeur ?
   (b) Quelles sont les différentes tâches impliquées dans le processus ? Par exemple : Le client nous envoie une demande par email, puis je vérifie la faisabilité de la demande, puis ...
   (c) Quel est le but de chaque tâche, sa valeur ?
3. (1h) **Interview : Concrétiser le modèle "Situation". Vérifier chaque tâche avec le participant et modifier ou rajouter les tâches manquantes. Ne pas déjà commencer à évoquer des solutions, le fait d'avoir déjà testé des solutions est uniquement pour que vous ayez déjà quelques idées et peut-être posé quelques questions pour éclaircir la situation de l'entreprise.**
   Suivre la démarche suivante :
   (a) **Être prêt à noter 5 citations qui résument l'interview**
   (b) Quel est le processus ciblé ? Quelle est sa valeur ?
   (c) Quelles sont les différentes tâches impliquées dans le processus ?
   (d) Quel est le but de chaque tâche, sa valeur ?
   (e) Quelles sont les personnes impliquées dans chaque tâche ?
   (f) Combien de ressources sont dépensées par tâche ? Nombre d'heures (jours) pour la compléter, Pourcentage de succès, Nombre de fois par semaine que la tâche est réalisée, ...
   (g) Comment est-ce que la tâche est réalisée ? Est-ce en utilisant un outil spécifique ? Excel ? Email ? Post-it ?
   (h) Mettre en évidence les tâches pénibles ou à améliorer
   (i) **Fixer un rendez-vous pour la semaine prochaine.**
   (j) **Demander un feedback sur comment s'est déroulé l'entretien, qu'est-ce qui pourrait être amélioré ? Est-ce que réaliser ce modèle leur semble utile ? Est-ce que vous pourriez améliorer votre façon de présenter ou communiquer ? etc...**
   (k) **Une fois l'interview fini, remplir le document Word "Évaluation continue" de suivi de projet et le publier sous format PDF (+ remplir le questionnaire) sous l'onglet "Progrès" de la semaine correspondante**

II Objectifs de l'entreprise

1. (30mins) Réaliser l'interview

Semaine 4 2ème v-c, ébauche du modèle "Sélection" et présentation d'une solution

I Objectifs de l'étudiant

1. (1h) Préparation du modèle "Sélection". Ce modèle se réalise en deux fois. Pour cet interview, vous devez mettre en évidence les critères important pour l'entreprise afin d'accepter votre solution (la partie gauche du modèle). Pour représenter ces critères, vous devez copier/coller les 5 tâches décrites dans le modèle du processus "Situation" qui vous semble importantes à améliorer. Puis, mettre en évidence les "Pertes" et/ou "Gains" liés à ces tâches. Ceci à pour but d'amener la discussion avec l'entreprise sur les critères de réussite de la solution. Il est conseillé de se focaliser sur un maximum de 5 critères afin d'éviter de s'éparpiller. Ces critères définis au début du projet vous permettrons de valider votre solution à la fin de ce dernier. Par exemple : Un critère serait de réduire de 2 heures la tâche validation des projets par semaine. Cela vous permets aussi, à la fin du projet, de tirer des conclusions comme par exemple : Vous avez été d'accord avec le participant que la solution remplissait les 5 critères de succès, néanmoins la motivation à adopter la solution par les "testeurs" n'a pas été un succès... Pourquoi ?
2. (1h) Choisir une solution à présenter et préparer une démonstration. Pour cela, il faut que vous réfléchissiez à une "histoire" à raconter afin que le participant comprenne bien comment vous vous imaginez l'application de cette solution dans son entreprise.
3. (1h) Interview : Commencer l'interview en revenant sur le modèle "Situation" afin de le faire valider "en live" par l'entreprise. Puis, passer sur le modèle "Sélection" et pour amener l'entreprise à le corriger. Commencer par demander si la partie "Utilisateur" est correcte. Est-ce qu'il manque des "Tâches" importantes à améliorer ? Est-ce que les "Pertes" et "Gains" sont justes ? Ajouter un maximum de détails quantifiables, coûts en temps et argent de la tâches ?
   (a) **Être prêt à noter 5 citations qui résument l'interview**
   (b) Est-ce que la tâche "A" vous permet réellement d'obtenir le bénéfice "1" ?
   (c) Est-ce qu'il est vraiment pénible de réaliser la tâche "A" à cause de "2" ?
   (d) Quels sont les 5 critères les plus importants pour que vous puissiez adopter une solution ? Comment pourrait-on les quantifier / évaluer ?
   (e) **Une fois la discussion finie sur le modèle "Sélection, vous pouvez continuer par une présentation "en live" d'une des 5 solutions que vous avez testé. Cela devrait vous permettre d'obtenir une première réaction afin de savoir si vous êtes sur la bonne voie.**
   (f) **Noter toutes les réactions et commentaires du participant face à la solution. Qu'est-ce qui n'a pas plu ? Qu'est-ce qui manque ? Etc...**
   (g) **Fixer un rendez-vous pour la semaine prochaine.**
   (h) **Demander un feedback sur comment s'est déroulé l'entretien, qu'est-ce qui pourrait être amélioré ? etc...**
   (i) **Une fois l'interview fini, remplir et publier l'évaluation continue (+ le questionnaire) sous l'onglet "Progrès"**
4. (1h) Approfondir la solution présentée si le participant l'a aimée. Essayer de trouver des réponses ou solutions aux problèmes soulevés par le participant.

II Objectifs de l'entreprise

1. (30mins) Réaliser l'interview

Semaine 5 3ème v-c, Présentation de solutions "en live" et réalisation du premier tutoriel

I Objectifs de l'étudiant

1. (1h) Préparer la démonstration de deux autres solutions pour l'interview. Il est impératif que vous présentiez au moins trois solutions différentes afin de donner une vision assez "globale" de plusieurs alternatives au participant.
2. (1h) Interview : Vous réalisez une démonstration en live de deux autres solutions avec une discussion ouverte. Le but étant que vous puissiez définir la ou les solution(s) que vous allez faire tester aux restes de l'entreprise.
   (a) **Être prêt à noter 5 citations qui résument l'interview**
   (b) Quelle est la (les) solution(s) que vous préférez, pourquoi ?
   (c) Quels sont les bénéfices perçus ?
   (d) Qu'est-ce qu'il manque à la (aux) solution(s) ? En quoi cela améliorerait les tâches ?
   (e) Avez-vous des questions sur la solution ?
   (f) Que devrais-je approfondir sur la solution ?
   (g) Comment pourrais-je améliorer la vidéo ? Sur quoi souhaiteriez-vous que je concentre mes tutoriels sur la solution ? Ces vidéos nous seront utile pour présenter et faire tester la solution à l'équipe par la suite.
   (h) Il serait bien de définir une équipe de 5 utilisateurs pour tester la solution (potentiels utilisateurs) (clients, collaborateurs, ou partenaires). Ces derniers recevront la semaine prochaine des liens vers des tutoriels pour prendre en main la solution. Merci de me communiquer leurs emails.
   (i) Pourriez-vous vous créer un compte d'essai sur la solution pour la prochaine rencontre ?
   (j) **Fixer un rendez-vous pour la semaine prochaine.**
   (k) **Demander un feedback sur comment s'est déroulé l'entretien, qu'est-ce qui pourrait être amélioré ? etc...**
   (l) **Remplir et publier l'évaluation continue (+ le questionnaire) sous l'onglet "Progrès"**
3. (1h) En se basant sur la présentation live de vos solutions à l'entreprise Réaliser une courte vidéo introduisant une des trois solutions et la publier sur la plate-forme. Ceci afin que je puisse vous donner un retour avant de réaliser les deux autres. La vidéo de maximum 4 minutes doit être une mise en situation de la solution pour l'entreprise. Vous ne devez pas décrire la solution (par ex : "Pour ouvrir un compte, vous cliquez ici..."). Il faut imaginer que la personne connaît déjà la solution est que vous lui montrer comment elle pourrait l'utiliser dans ses tâches quotidiennes. Vous devez raconter une histoire (par ex : "Le matin, lorsque les ouvriers arrivent sur un chantier, ils reçoivent des notifications avec les objectifs de la journée, ensuite vous voyez apparaître ici l'avancement du projet, et envoyez une validation au directeur, ...). Penser à bien mettre l'accent sur pourquoi, d'après-vous, la solution remplit les 5 critères de succès de l'entreprise. La vidéo peut être enregistrée à l'aide de PowerPoint, le montage avec Window Movie Maker ou Quick Time et la compression en MP4 avec audio en MP3 avec CloudConverter.com. Il est plus facile de laisser tourner l'enregistrement lors d'une erreur et recommencer sa phrase puis d'enlever l'erreur au montage que de chercher à faire une vidéo parfaite en un seul coup.
4. (1h) Planifier une rencontre avec Quentin pour discuter de vos critères de sélection + de vos impressions sur la réaction de l'entreprise face à votre solution.

II Objectifs de l'entreprise

1. (30min) Réaliser l'interview.

Semaine 6 4ème v-c, Validation du modèle "Sélection", ébauche du modèle "Prototype", et réalisation des tutoriels

I Objectifs de l'étudiant

1. (1h) Préparer l'interview soit en approfondissant les solutions déjà présentées qui ont été retenues par le participants, soit en cherchant d'autres solutions. Cependant, il est impératif qu'à la fin de cet interview, le participant et vous soyez d'accord sur une ou des solution(s) à faire tester à son équipe. Cela afin que vous puissiez réaliser les tutoriels sous forme de vidéos pour son équipe. Faire une ébauche d'un scénario prototype (sous forme d'un processus dans le modèle "Prototype") qui servira de base pour construire vos tutoriels.
2. (1h) Cet interview est une discussion ouverte sur la sélection finale pour le projet d'une ou de solution(s) à tester. Cela signifie que vous allez commencer par valider le modèle "Sélection", puis, vous présentez le scénario (fil rouge) avec le modèle "Prototype" sur lequel vous allez construire les différents tutoriels.
   (a) **Être prêt à noter 5 citations qui résument l'interview**
   (b) Comment voyez-vous l'application de cette solution dans votre entreprise ?
   (c) Quelle tâche risque d'être délicate à changer ?
   (d) Qui dans l'équipe "test" aura quel rôle ? Quelle responsabilité dans la solution ?
   (e) Qui sera responsable de son implémentation et de former les personnes ?
   (f) Est-ce que le scénario vous semble adéquat ? Trop simple ? Trop compliqué ?
   (g) D'ici la fin de la semaine, je vais réaliser des tutoriels pour votre équipe "test". Est-il possible que vous leur envoyez un email avec le lien vers les vidéos. Ainsi, dès la semaine prochaine, nous pourrons commencer à tester la solution. Merci de me mettre en copie afin qu'ils puissent me contacter si besoin.
   (h) Avez-vous des questions sur la solution ?
   (i) **Fixer un rendez-vous pour la semaine prochaine.**
   (j) **Demander un feedback sur comment s'est déroulé l'entretien, qu'est-ce qui pourrait être amélioré ? etc...**
   (k) **Une fois l'interview fini, remplir et publier l'évaluation continue (+ le questionnaire) sous l'onglet "Progrès"**
3. (2h) Réalisation de tutoriels. Les vidéos doivent être structurées en plusieurs parties (vidéos de 5 mins à chaque fois).
   (a) La 1ère partie explique comment prendre en main la solution (Création d'un compte, paramétrage de la solution, du profil, se rajouter dans l'équipe "test", etc...)
   (b) Les parties suivantes montrent les différentes fonctions de la solutions qui remplissent un critère de succès défini. L'idée de faire plusieurs vidéos étant de clairement séparer les bénéfices de la solution. Cela permet de se faire une image plus net du potentiel et fonctionnement de la solution.
4. **U**ploader les vidéos sur NousInnovons et envoyer un email (avec l'URL des vidéos et les directives que vous attendez de la part de l'équipe pour tester la solution) au participant afin qu'il puisse le transmettre à l'équipe. L'email ressemblera (avec un peu plus de politesse) à :
   "Bonjour,
   Vous trouverez ci-joint trois vidéos introduisant la solution "Trello" comme discuté. La première est une introduction générale pour se créer un compte et comprendre les points clés de la solution. –> Lien Vidéo 1
   La 2ème vidéo s'adresse à vos secrétaires qui sont en charge de gérer la classification des nouvelles offres –> lien Vidéo 2
   La 3ème vidéo est pour les techniciens qui doivent mettre à jour le statu des offres – lien Vidéo 3.
   Merci de faire suivre cet email aux personnes concernées par le test de la solution."

II Objectifs de l'entreprise

1. (30mins) Réaliser l'interview
2. Soutenir l'étudiant dans la phase test. S'assurer que tous les membres de l'équipe "test" prennent le temps nécessaire pour réaliser les tutoriels.

Semaine 7 5ème v-c, Support et suivi de l'étudiant dans le test des tutoriels par l'entreprise

I Objectifs de l'étudiant

1. (1h) S'assurer que l'équipe "test" réalise les tutoriels (le scénario) dans la semaine. Envoyer un email en début de semaine pour vous présenter à l'équipe et en rappelant les objectifs de chacun pour cette semaine, qui doit faire quel tutoriel. Relancer par email si besoin dans le courant de la semaine. Répondre aux questions éventuelles.
2. (1h) Approfondir la solution en fonction des remarques et évaluations des participants. Les remarques et évaluations des participants peuvent être postées directement sur la page des vidéos.
3. (1h) Interview : Finaliser le modèle "Prototype" et essayer de l'approfondir avec le participant.
   (a) **Être prêt à noter 5 citations qui résument l'interview**
   (b) Comment pourrait-on utiliser la solution dans d'autres processus ?
   (c) Qui d'autres pourrait-on amener à utiliser la solution ? Améliorer la transparence/relation avec le client ?
   (d) Quelles ont été les réactions des membres de l'équipe "test" ?
   (e) Qui semble motivé pour "pousser" l'adoption de la solution dans l'entreprise ?
   (f) Devons-nous revoir le scénario ?
   (g) Avez-vous des questions sur la solution ?
   (h) **Demander au participant de valider le modèle "Prototype".**
   (i) **Fixer un rendez-vous pour la semaine prochaine.**
   (j) **Demander un feedback sur comment s'est déroulé l'entretien, qu'est-ce qui pourrait être amélioré ? etc...**
   (k) **Une fois l'interview fini, remplir et publier l'évaluation continue (+ questionnaire) sous l'onglet "Progrès"**

II Objectifs de l'entreprise

1. (30mins) Réaliser l'interview
2. Appuyer l'étudiant dans la phase test. S'assurer que les collaborateurs impliqués comprennent l'importance de tester la solution. Récolter les impressions.

Semaine 8 6ème v-c, Ébauche du modèle "Stratégie" et conclusion du test

I Objectifs de l'étudiant

1. (2h) Approfondir la solution, chercher des réponses aux questions de l'entreprise.
2. (1h) Remplir la partie actuelle du modèle "Stratégie". Ce modèle cherche à mettre en évidence la culture de l'entreprise et les barrières que cela pourrait entraîner lors de la transformation du processus. Pour remplir la partie actuelle de ce modèle, il vous faut identifier quels sont les différentes actions qui posent problème aujourd'hui. ceci vous permets de cibler les croyances qui potentiellement impacteront l'adoption de votre solution. Pour quelle raison un collaborateur prend plus de temps que nécessaire sur cette tâche, ou pour quelle raison il a tendance à passer au-dessus de cette tâche ? Puis, depuis ces croyances, il faut identifier quelles sont les expériences qui ont développé ces croyances. Ex : Parce que l'employé a expérimenté que s'il oublie cette tâche, il reçoit un blâme alors que pour l'autre tâche, il peut toujours récupérer le coup par la suite si nécessaire. **Le modèle s'appelle "Stratégie" car il vous permets d'évaluer ce qui pose problème aujourd'hui et ce qui pourrait poser problème avec l'adoption de votre solution et essayer de définir des stratégies d'adoption pour l'entreprise. Il faut aussi utiliser les retours, impressions quant à la "motivation", "facilité", "temps alloué", etc... à participer au test pour compléter l'ébauche du modèle "Stratégie". Quelles sont les expériences des "testeurs" avec la solution qui ont posé problèmes ?**
3. (1h) Interview : Expliquer le modèle "Stratégie" au participant et chercher avec lui à le compléter et corriger.
   (a) **Être prêt à noter 5 citations qui résument l'interview**
   (b) Est-ce que toutes les actions sont représentées ?
   (c) Quelles sont les actions qui "bloquent" souvent un projet ?
   (d) Qu'est ce qui à bloqué lors du test ? Lorsqu'ils ont essayer de suivre le scénario ?
   (e) Sont-ils mal à l'aise dans la réalisation de ces tâches ? Perçoivent-ils des tâches comme plus importantes ?
   (f) Quelles sont les expériences qui produisent ces croyances, impressions qu'ont les collaborateurs ?
   (g) Qu'est-ce que les "testeurs" ont mis en évidence comme problèmes ou manques dans la solution ? Pour quelle raison ?
   (h) Merci d'essayer d'observer votre entreprise jusqu'à notre prochaine rencontre afin d'essayer de mettre en évidence certaines croyances et expériences. Lors de meetings, rendez-vous chantier, aux pauses repas, lors de téléphones ?
   (i) **Fixer un rendez-vous pour la semaine prochaine.**
   (j) **Demander un feedback sur comment s'est déroulé l'entretien, qu'est-ce qui pourrait être amélioré ? etc...**
   (k) **Une fois l'interview fini, remplir et publier l'évaluation continue sous l'onglet "Progrès"**

II Objectifs de l'entreprise

1. (30mins)Réaliser l'interview
2. Observer l'entreprise afin d'essayer de définir les croyances et expériences

Semaine 9 7ème vidéo-conférence, finalisation du modèle "Stratégie" et de la phase test

I Objectifs de l'étudiant

1. (1h) Approfondir la solution ou améliorer les vidéos en fonction des remarques de l'entreprise.
2. (1h) Remplir la partie transformation du modèle "Stratégie". Dans cette partie, il vous faut réfléchir à quelles croyances vont potentiellement agir contre l'adoption de la solution. Puis de proposer des expériences qui peuvent changer ces croyances afin de promouvoir des nouvelles valeurs, actions et résultats qui renforceront l'adoption de la solution. Par exemple, dans le cadre d'une solution collaborative, si l'entreprise n'a jamais réellement travaillé de manière collaborative, il faut trouver des expériences qui montreront à quel point le collaboratif est important pour l'entreprise. Exemple : Une expérience serait de commencer à demander des feedbacks lors de meetings de la part de tout le monde. Une autre serait de récompenser les collaborateurs qui ont pousser à la collaboration et afficher clairement combien de temps ils ont fait gagner à leur collègues. Une 3ème serait de mettre en place un système de carte postale en interne ou chacun devrait, chaque jour, envoyer soit un remerciement, soit une remarque à un collègue. Cela afin de renforcer le partage d'impressions. Finalement, inclure un nouveau "slogan" pour l'entreprise du style : Blamer n'est pas en cas d'échec, mais ça l'est lorsqu'on échoue à aider ou demander de l'aide (Lego slogan). Il est important de prendre suffisamment de temps pour bien définir quels sont les nouveaux résultats / valeurs (au niveau stratégique) que l'on souhaite atteindre grâce à la solution. Puis de d'écrire sur le modèle tout ce qui vous passe par la tête comme expériences favorisant ces résultats / valeurs.
3. (1h) Fixer une rencontre avec Quentin afin de discuter de vos idées de transformations.
4. (1h) Interview : Finaliser le modèle "Stratégie" avec le participant. Expliquer vos idées pour transformer la culture d'entreprise en adéquation avec les solutions digitales.
   (a) **Être prêt à noter 5 citations qui résument l'interview**
   (b) Quelles sont les croyances ou expériences que vous avez pu observer durant cette semaine ?
   (c) Que pensez-vous de mes idées d'expériences à promouvoir dans l'entreprise ?
   (d) Quelles expériences pourraient pousser les collaborateurs à adopter les nouvelles valeurs ciblées, qui par la suite favoriseront l'utilisation de la solution ?
   (e) Pourquoi ces expériences ne peuvent pas être changées si facilement ?
   (f) **Demander de valider le modèle.**
   (g) **Fixer un rendez-vous pour la semaine prochaine.**
   (h) **Demander un feedback sur comment s'est déroulé l'entretien, qu'est-ce qui pourrait être amélioré ? etc...**
   (i) **Une fois l'interview fini, remplir et publier l'évaluation continue (+ questionnaire) sous l'onglet "Progrès"**

II Objectifs de l'entreprise

1. (30mins)Réaliser l'interview
2. Observer l'entreprise afin d'essayer de définir les croyances et expériences

Semaine 10 8ème v-c, réalisation du modèle "Conclusion"

I Objectifs de l'étudiant

1. (2h) Préparer le modèle "Conclusion" pour l'interview. Celui-ci se base sur les réponses obtenues des participants et les observations de l'étudiant. Le but étant de mettre en évidence les facteurs contextuels de l'entreprise afin d'évaluer les potentielles barrières et risques de la solution. Celui-ci doit aussi soulever les points qui ont bloqué pendant la phase test. Vous devez mettre en avant les "learnings" du projet. Ils doivent permettre de définir l'étape suivante dans le projet, comment l'entreprise devrait continuer, ce que vous avez appris, etc... Puis, par la suite, essayer de penser à des stratégies pour réduire les barrières ou éviter les risques. Par exemple, si un commentaire mais en avant la difficulté d'inclure la nouvelle solution dans un emploi du temps. Cela signifie que au niveau de la structure de l'entreprise, il est nécessaire de la repenser pour réussir à définir un moment précis dans le planning de tous les utilisateurs pour l'utilisation de la solution. Les questions à se poser sont :
   (a) Connaissances internes et externes : Quelles sont les connaissances des collaborateurs qui peuvent aider à l'adoption de la solution ? Est-ce que la solution est similaire à une déjà utilisée ? Quelles sont les connaissances de partenaires, clients, ou compétiteurs qui pourrait aider à l'adoption de la solution ? Est-ce qu'une solution similaire est utilisée chez l'un d'entre eux ? etc..
   (b) Relations d'apprentissages : Comment est-ce que les gens collaborent ? Est-ce qu'ils ont l'habitude de collaborer, ou tout le monde fait ce qu'il a à faire ? Sont-ils souvent isolés dans des places de travail différentes ? etc..
   (c) Représentation mentale des collaborateurs : Comment les collaborateurs perçoivent la nouvelle approche apportée par la solution ? Est-ce que la valeur de la solution est très clair pour eux ? Est-ce que les valeurs importantes pour eux sont en adéquation avec la solution ?
   (d) Processus et structure : Est-ce que les processus et la structure existants sont adaptés à la solution ? Est-ce que l'entreprise à des processus bien établis ? Ou chacun manage son temps comme il le souhaite ? Est-ce que les personnes sont au courant de l'emploi du temps des autres ? Est-ce que la structure est hiérarchique ou fonctionnelle ? Chacun sait qui est responsable de quoi ? En quoi cela peut aller à l'encontre de la solution ? Est-ce que la solution permet de renforcer le type de structure ou processus ? Devront-ils changer énormément leur façon de travailler, leur processus avec la solution ?
   (e) Stratégie de l'entreprise : Est-ce que la solution est en adéquation avec la stratégie de l'entreprise ? Quelle est la stratégie de l'entreprise ? Est-ce que l'innovation est importante ? Est-ce la relation client ? Travaillent-ils avec des anciens ou nouveaux clients ? Sur du long-terme ? Sont-ils sur la quantité ou la qualité ? etc..
2. (1h) Ce dernier interview est plus une discussion ouverte sur les conclusions de ce projet. Voici quelques pistes :
   (a) **Être prêt à noter 5 citations qui résument l'interview**
   (b) Expliquer le modèle "Conclusion" et le faire valider. Quels sont les "learnings" que l'entreprise et l'étudiant ont appris après ce projet ?
   (c) Mettre en évidence les potentielles risques liés à la solution.
   (d) Discuter de stratégies pour réduire les barrières ou risques.
   (e) Dire au revoir et remercier.
   (f) **Demander un feedback sur comment s'est déroulé le projet en général, qu'est-ce qui pourrait être amélioré ? etc...**
   (g) **Une fois l'interview fini, remplir et publier l'évaluation continue (+ questionnaire) sous l'onglet "Progrès"**

II Objectifs de l'entreprise

1. (30mins) réaliser l'interview

Semaine 11 Rédaction du rapport et ébauche modèle "Vision"

I Objectifs de l'étudiant

1. (2h) Travail sur le modèle "Vision".
2. (2h) Rédaction du rapport.

Semaine 12 Rédaction du rapport

I Objectifs de l'étudiant

1. (2h) Travail sur le modèle "Vision".
2. (2h) Rédaction du rapport.

3. Sample of twenty weekly reports from students over the 69 collected

Nom	Partage cinq citations du participant qui décrit l'interview	Qu'as-tu aimé cette semaine ?	Que n'as-tu pas aimé cette semaine ?
Mathieu	1) "On est obligés de faire du BIM. 2) "Crainte sur la propriété intellectuelle" 3) "Chacun dans son coin pour l'instant" (pas de partage de maquette) 4) "Problématique du niveau de détail des maquettes" 5) "Travail plus soutenu au début"	Me dire que j'allais bosser sur qqch de passionnant.	Rien
Sophia	1)J'ai bien aimé cette solution car elle était facile à prendre en main. 2)Le prix est intéressant à titre de comparaison avec une solution comme Mobatime. 3)Est-ce qu'on peut importer des utilisateurs directement ?" 4)"Peut-être qu'une solution pour la facturation sera quelque chose à voir en plus car c'est un service qu'on offre" 5)"Calamari permettrais au personnel de champs d'avoir un badge à code QR pour le décompte des heures"	Lui présenter un premier modèle	Je trouve que, même si c'est du travail intéressant, ça me fait beaucoup quand même.
Lucas	1) "C'est ce que je fais à chaque fois pour un nouveau projet" (en parlant de l'utilité du modèle actuel pour le projet) 2) "Si je ne réponds pas assez vite ils se passent des informations" 3) "idéalement visualiser les photos sur une carte" 4)"important de pouvoir vérifié si des infos existent déjà" 5) "Il n'y que moi qui sache utiliser la base SIG"	L'interview	Le stress avant ce première interview
Guillaume	1) Je vois comment la solution va amener l'entreprise à résoudre le problème. 2) J'ai pensé que c'étaient des solutions pour la NASA, maintenant je comprends mieux. 3) Le projet avance parfaitement. 4) C'est un sujet que je n'avais pas pensé.	La discussion et présentation de la solution	Établir les pertes et gains quantitatifs.

Chloé	1)"La solution permet de traiter l'avant-vente". 2)"Il faudrait ajouter la possibilité de faire des devis directs pour les commerciaux" 3) "Distinction nécessaire entre état du contrat au niveau de l'avant-vente" 4) "L'exportation des données doit être possible"	Le fait de recentrer le sujet et la problématique.	Retard et pas de test de la solution proposée de la part de l'interlocuteur.
Romain	1) "La plateforme est jolie et semble facile à prendre en main" 2) "Elle ressemble à ce qu'on cherche à avoir comme outil" 3) "Elle n'est malheureusement pas intégrable dans Polypoint" 4)"Il faudrait contacter Polypoint et Abacus pour savoir ce qu'ils proposent comme outil de gestion des vacances" 5) "Merci pour le travail"	L'interview	Devoir recommencer à chercher une solution
Lucas	1) "Certain critère ou process ne sont pas quantifiable" 2) "une solution qui demande du travail de la part d'une personne pour la mise en place n'est pas forcément mauvaise" 3) "par contre plus de quelques minutes d'apprentissage pour les usagers et ils ne le feront pas" 4) "My Maps offre le résultat attendu pour les photos"	Présenter mes solutions	Pas toujours facile de s'organiser autour de l'interview
Mathieu	1) "On a une image à respecter" (parlant d'identité visuelle) 2) "Parfois on est plus de trois personnes sur un word" 3) "On en a à faire avec ces portes" 4) “Je ne suis pas là pour les pompoms et les guirlandes" (parlant de production de documents) 5) "Il faut que revient au temps où il fallait réfléchir deux minutes où poser un mur et pas tout faire à l'arrache"	Approfondir le logiciel	Rien
Guillaume	1) Chaque solution à une partie intéressante. 2) SharePoint était en fait déjà disponible sans que nous le sachions. 3) Nous allons tester avec 3 personnes dans un premier temps. 4) Je vois mieux comment les différentes solutions vont fonctionner. 5) Je me réjouis de la suite.	Préparation de l'interviews	Le rapport

Sophia	1) solution peu coûteuse. 2) intéressant que ce soit suisse. 3) s'adapte mieux à nos besoins liés au marché suisse. 4) Permet de faire beaucoup de chose. 5) pourrait même remplacer toute la comptabilité à premier à bord.	Au final, j'ai vu juste vu que c'est ce qu'il attendait et il ne voulait pas.	Que les progrès ont été repoussés
Guillaume	1) Je ne sais plus trop où on en est. 2) Il faut vraiment que je me force à utiliser que ça. 3) Il faut que je travaille une heure par jour pour classer mes fichiers sur Sharepoint. 4) On ne se rend pas compte de tout le potentiel de ces solutions. 5) Il faut que je prenne des cours sur Sharepoint dans le futur pour pouvoir tout utiliser les fonctionnalités.	L'interview même s'il était long et éprouvant mais on a bien bossé.	Ecrire le rapport.
Younes	1) j'ai bien aimé la solution parce que ça rassemble toutes les informations dans un seul fichier. 2) c'est pratique de pouvoir manipuler depuis une application, ça fait gagner du temps	Présentation de la solution	Rien
Lucas	1) "la solution semble plaire de manière unanime" 2) "la solution sur les photos ne fonctionne pas comme voulu" 3) "elle reste la seule option disponible il semblerait" 4)"nous allons nous concentrer sur l'aspect des projets et laisser les photos de côté pour l'instant" 5) "c'est notre objectif que cette solution soit adoptée dans l'entreprise"	Voir que l'entreprise est motivée à mettre en place la solution.	Rien
Sinan	1) On n'a pas vraiment d'information pour répondre à cette question 2) Ca nous prend beaucoup de temps à vérifier les choses 3) Je rajouterai confirmation du client comme étape intermédiaire 4) Le cout total est plus ou moins 5) Je pense que vous avez bien regroupé les différents flux de l'entreprise	Que grâce à ce flowchart, j'ai pu avoir une vision globale de l'entreprise	Rien

Sélim	1) "En faites, vous êtes un facilitateur de vie" 2) (On parlait d'un système de classement d'information) "On a un serveur qui nous coute cher et en plus il est crypté, donc s'il tombe en panne on ne pourra pas lire les informations dessus"	La validation des modèles	Rien
Julien	1)"Nous avons implémenté Google Agenda et les employés sont contents", 2)"Je trouve qu'avec un peu d'utilisation et de pratique, cette solution est facile à prendre en main" 3) "Nous voulons quelque chose de simple et Macrogantt est très adapté	L'interview	Rien
Yassine	1) "Cette solution nous fait gagner du temps" 2) "Cette solution est très pratique car visible et modifiable par tous" 3) "Ces solutions sont gratuites" 4) "Pouvoir avoir accès aux documents partagés en dehors du bureau est très pratique (ex: retrouvé un numéro de téléphone en déplacement sur le chantier) 5) "La visibilité et les couleurs du Google Agenda sont à revoir"	Cette séance d'échange avec les employés, très agréable et formatrice	Rien
Marcel	1)"Airtable est vraiment top" 2)"On a essayé pleins de combinaisons, tout est possible" 3)"Le prix est similaire à Trello" 4)"C'est un outil peu connu..." 5)"Votre proposition est vraiment adaptée à notre besoin"	Le retour d'expérience sur Airtable.	Certains bugs avec la platform.
Sinan	1) Y a des aspects que je n'avais pas pensé qui sont dans Current RMS 2) Il faut voir si les softwares de comptabilité adapté pour Rentman et Current RMS sont adapté pour la Suisse 4) Je pense qu'on peut laisser de côté l'intégration de Office 365	On converge gentiment vers un résultat	Rien
Alexis	Le président : 1) "Cette solution est un miracle, je suis certain que ça va marcher pour le marché anglophone et le canton de Vaud" 2) "Nous avons besoin de quelqu'un de disponible pour se former, avec temps à investir, c'est le potentiel blocage à mon avis... avec la qualité du support chez Microsoft"	Faire les entretiens et avoir des avis extérieurs sur la solution	Rien

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Experience

2014 – 2019 **Researcher**
Logistics, Economy, and Management Chair, EPFL, Switzerland

2017 – 2018 **Founder of the platform NousInnovons.ch**

2013 – 2014 **Humanitarian engineer**
NGO Pont-Universel, Switzerland and Benin

2011 – 2012 **Assistant statistician**
Public Ministry of Vaud, Switzerland

Education

2014 – 2019 **Ph.D. in Management of Technology**
Doctoral School of Management of Technology, EPFL, Switzerland

2017 – 2018 **Certificate (CAS) in Supply Chain**
International Institute for the management of Logistics & Supply Chain, EPFL, Switzerland

2012 – 2014 **M.Sc. in Conception and Production**
Mechanical Engineering, EPFL, Switzerland

Teaching

Lecturer	**Master's level course** Introduction to agile management methods
Supervisor	**Semester and master projects** More than forty students supervised

Publication and Presentation

Cavillier, Q. & Wieser, P. (2018). "Connecting Academia and Small Enterprises: A new field for Knowledge Management Experiments" *In Proceedings of the 15th International Conference on Intellectual Capital, Knowledge Management & Organisational Learning (p.30)*. ACPI

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Award

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